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FIELD GUIDE TO NORTHEASTERN
FERNS

EUGENE C. OGDEN
NEW YORK STATE MUSEUM

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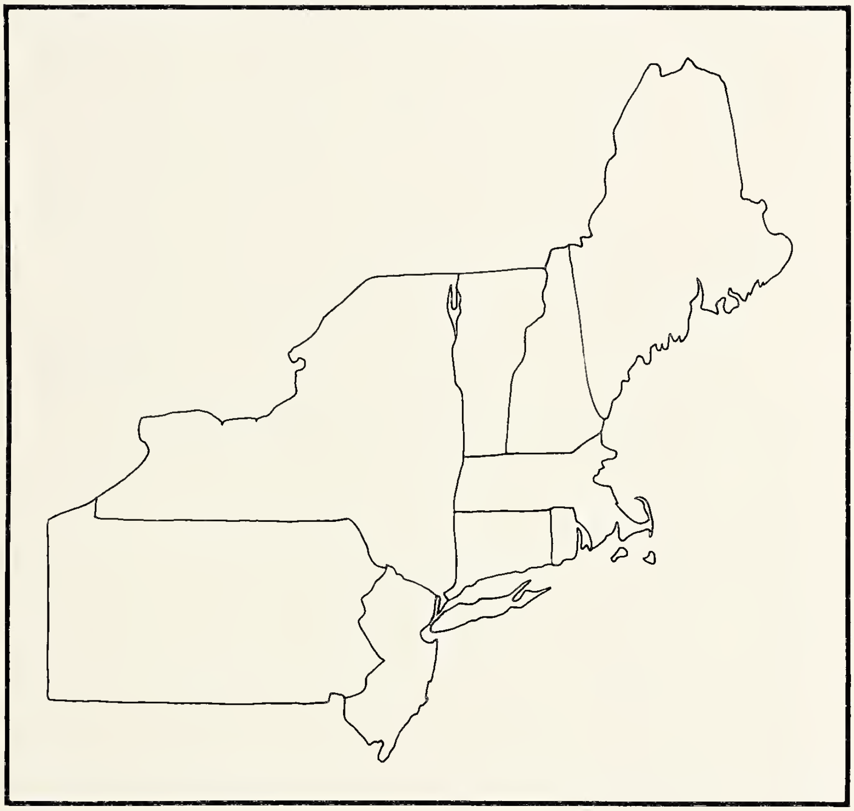
Bulletin Number 444
New York State Museum
The University of the State of New York
THE STATE EDUCATION DEPARTMENT
Albany, New York 12230
1981

Field Guide to Northeastern
FERNS

EUGENE C. OGDEN
New York State Museum

Illustrated by Anne E. Lacy and Kathryn M. Conway



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FOREWORD

THE AUTHOR of this publication was a pioneer in the development of the type of key (random access) used in this publication. It is his view that identification of plants in the field should not require that all parts of the plant be present. Since the fronds of ferns do not produce spores throughout the year, keys which depend heavily on "fruiting" characteristics are often useless. The users of this guide will find it to their advantage that there are more keys than species, for when one identification route is not successful another may be tried, almost insuring success. The keys in this book have been tested by groups in the field, amateur and professional alike, and by the author and his son on a home computer. This publication has been five years in the making, but we feel it was well worth the effort. We at the New York State Museum are proud to present such a carefully prepared and beautifully illustrated volume.

Richard S. Mitchell
State Botanist
New York State Museum

ABOUT THE AUTHOR

Dr. Eugene C. Ogden is a native of Michigan. He received his Ph.D. at Harvard University and taught at the University of Maine before coming to the New York State Museum, where he served as State Botanist until retirement in 1975. He was probably the first to use random access keys in 1953; these are very popular in numerical taxonomy today. He is known worldwide as an authority on dispersal of airborne pollen and as a taxonomist of pondweeds (*Potamogeton*).

ACKNOWLEDGMENTS

Among the many persons who have given much appreciated help, several should receive special mention: Richard S. Mitchell, State Botanist of New York, gave continuous encouragement and advice and checked all of the illustrations for accuracy. Charles Sheviak, Curator of the New York State Herbarium, supplied specimens for study and illustration. J. Kenneth Dean offered many valuable suggestions. John T. Mickel, Senior Curator of Ferns at the New York Botanical Garden, reviewed the manuscript and suggested several changes and improvements. Warren H. Wagner, Professor of Botany at the University of Michigan, critically checked the plates of illustrations before the final inking and supplied material of several rare or difficult species. Anne E. Lacy, professional artist, prepared the 60 plates and the cover from living and/or herbarium material and from projected slides. Kathryn M. Conway, staff illustrator, prepared all of the other illustrations. My wife, Edith, author of "The Ferns of Maine," was always available as a consultant on technical characters. My son, Everett, an electronic engineer, fed fern data into his computer, helped prepare the random access key, and sorted the data for the keys to groups of species.

INTRODUCTION

This guide for the identification of the native ferns of New York, New England, New Jersey, and Pennsylvania is prepared primarily for those with little or no botanical training. It is designed especially for field use with fresh specimens. Most of the characters referred to are easily seen, at least with the aid of a ten-power lens and a razor blade or sharp knife (a mini-knife with replaceable blades is excellent). Of course, if only sterile fronds (leaves) are available, the "fruiting" characters (from sori) cannot be determined. Even with fertile fronds, it is sometimes difficult or impossible to be sure of the type of indusium. Fortunately, the characters exhibited by the vascular bundles in the stipes are nearly always easily seen with fresh specimens. For this reason, they are here emphasized more than in most fern identification manuals. They are groups of specialized cells that in cross section (transverse cut) appear much different from the surrounding tissue. Do not confuse with cavities that may be present. Unfortunately these valuable characters can seldom be determined from dried material.

It would be helpful if collectors of ferns for permanent inclusion in a herbarium would indicate on the label or elsewhere the number and shapes of these bundles as seen in cross section of the stipe near its base and also near the blade. Better yet, a small diagram would also show positions and sizes.

This treatment is conservative, serving to identify generally accepted species. It is not meant to supplant more technical manuals which may profitably be used in conjunction with this bulletin. Although several families of ferns are included here, there is no attempt to indicate this. The purpose is identification, not classification. The species descriptions are listed in alphabetical order for ease of locating, rather than being placed in an order that would show their kinship to each other.

As treated here, 70 species in 29 genera have been reported for our area. Sixty of these are described and illustrated. The other ten, being very rare or perhaps extinct (or very similar to other closely related species) are mentioned and contrasted under the species they most closely resemble. Some taxa below the rank of species (subspecies, varieties, forms) are mentioned but not in detail. Hybrids are mentioned briefly, if at all; those commonly treated as species in recent manuals are cited as synonyms under one or both parents. Those interested may consult numerous publications where some disagreement will be found. The differences in names and classifications are primarily because of dates of publication, and thus variations in available knowledge about recent critical studies (cytologic, genetic, etc.). This is especially noticeable in the genus *Dryopteris*. The species descriptions indicate the appearance of the plants and the usual range of variation but not those forms that might be termed abnormalities. The illustrations attempt to indicate characters that are not as easily described in words.

The scientific names (which are international names) are composed of genus (noun) and epithet (modifier). When infraspecific categories are recognized, those terms are part of the scientific name. Sometimes, following the scientific name, may be found the name of the person or persons who authored the taxon. This author citation is not a part of the scientific name and may be used or not as one wishes. It is for bibliographic purposes and relates to the scientific name as does the name of the author of a book to the book's title. The complete author citation would include also the name, date, and page of the original publication.

The common names are those frequently used in our area and in floristic manuals. They can be very useful in local areas but sometimes may be confusing as several names may refer to the same plant and, worse, the same name may apply to different species.

Several publications that include our area, in whole or in part, are very useful, especially for the identification of ferns but in many other ways as well. They include:

Blaustein, Elliott H. 1979. Name that Fern. Saffyre Publications.

Brooks, Karl L. 1979. A Catskill Flora and Economic Botany. I. Pteridophyta. The ferns and fern allies. New York State Museum Bulletin No. 438.

Canan, Elsie D. 1946. A Key to the Ferns of Pennsylvania. Science Press Printing Company.

Chrysler, Mintin A. and J. L. Edwards. 1947. The Ferns of New Jersey, Including the Fern Allies. Rutgers University Press.

Cobb, Boughton. 1956. A Field Guide to the Ferns. Houghton Mifflin Company.

Fernald, Merritt L. 1950. Gray's Manual of Botany. American Book Company.

Mickel, John T. 1979. How to Know the Ferns and Fern Allies. Wm. C. Brown, Publisher.

Morton, Conrad V. in Henry A. Gleason. 1952. The New Britton and Brown Illustrated Flora of the Northeastern United States and Adjacent Canada. Volume I. New York Botanical Garden.

Ogden, Edith B. 1948. The Ferns of Maine. The Maine Bulletin. University Press, Orono, Maine. Reprinted by Thorndike Press, Thorndike, Maine and University of Maine at Orono Press.

Scamman, Edith. 1947. Ferns and Fern Allies of New Hampshire. New Hampshire Academy of Science, Durham, N. H.

Seymour, Frank C. 1969. The Flora of New England. Charles E. Tuttle Company.

Small, John K. 1935. Ferns of the Vicinity of New York. Science Press Printing Company.

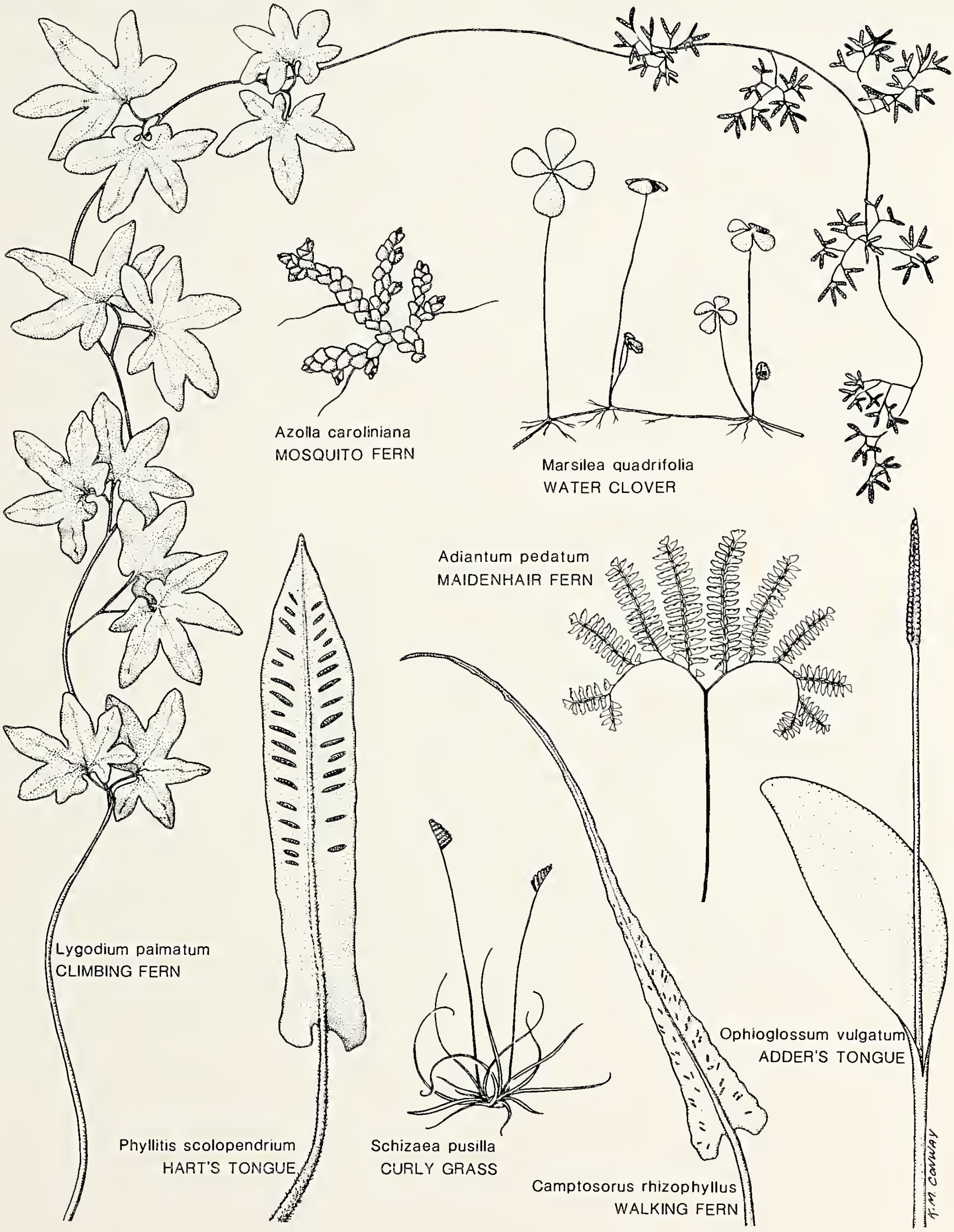
Wherry, Edgar T. 1961. The Fern Guide. Doubleday and Company. Photocopy by The Morris Arboretum of the University of Pennsylvania.

Wiley, Farida A. 1948. Ferns of Northeastern United States. The American Museum of Natural History of New York City.

If in one or more of these publications a species is called by a different scientific name than the one used here, that name is given as a synonym without author citation. It may or may not be a full synonym according to the original author but is a synonym, at least in part, in one or more of the books suggested as being especially useful for our area. For example: *Polypodium vulgare* Linnaeus is not a synonym of *Polypodium virginianum* Linnaeus, but it is a synonym as found in some floras that include the northeastern United States.

FERNS WITHOUT FERNLIKE DISSECTED FRONDS

Eight genera of ferns in our area, each with a single species, lack the pinnately dissected fronds usually associated with ferns. They are here illustrated sufficiently for recognition and are excluded from the keys to ferns with dissected blades. Descriptions are found in alphabetical order with the other ferns. These genera are: *Adiantum, Azolla, Camptosorus, Lygodium, Marsilea, Ophioglossum, Phyllitis,* and *Schizaea.*



RANDOM ACCESS KEY TO SPECIES WITH DISSECTED FRONDS

This key differs from the usual keys found in floristic manuals, for here the user makes all of the choices in any order, being influenced by which characters are most easily determined, rather than in the order chosen by the author of the key. It uses a list of numbers, one through 52, representing the 52 species in the key. For this, the pages of numbers that are supplied in the back of the bulletin (or photocopies of them) may be employed.

The eight species illustrated under FERNS WITHOUT FERNLIKE DISSECTED FRONDS (Page 3) are not included in this key.

Choose any character among the 93 listed that agrees with the material at hand and delete the numbers that follow the chosen statement. Continue in this way with any other characters, in any order, until only one number is left or no further characters are exhibited by the plant material. Reference to the numbered list (page 18) will indicate the possibilities.

For example: if "leafy blades pinnatifid" is chosen, only the numbers 15, 31, 33, and 41 remain. If we now choose "veins not reticulate and mostly forked two or more times," we delete 31 and 33, leaving 15 and 41. We might now choose "leafy blades 20-50 cm long" which eliminates 15, leaving only 41. The numbered list of species indicates that the specimen is *Polypodium virginianum*. Comparison with the description (text and illustrations) should indicate if the correct identification has been made.

An alternate procedure (which does not require a sheet of numbers but merely a bit of scrap paper) is: first choose a statement that agrees, write down only the numbers that do not appear (and thus remain as possibilities), then continue in the usual way.

The numbers following the statements are those of the species that *do not* agree. This has been found to increase both accuracy and speed. In seeking the identity of a specimen, all keys proceed to this end by eliminating those that do not agree with the characters exhibited by the specimen.

When complete parts with recognizable characters are available, this key should proceed smoothly to one species. Even when some parts are missing or unclear, it may eliminate all but a few in one genus. The KEYS TO SPECIES WHEN GENUS IS KNOWN will help to make the final determinations. If, after the available characters are used, species in more than one genus remain, reference to the DESCRIPTIONS OF SPECIES should help. These are listed in alphabetical order by genus and species.

Field use of this key has indicated that among the better characters for early use are: dissection of leafy blades and bundles at base of stipe. However, if some characteristic of the specimen appears to be outstanding, it should be chosen early. If the specimen appears to be *very* small or *very* large, then size of frond might eliminate many species. Other useful characters to be used early are stipe length when *much* shorter or *much* longer than blade, basal pinnae when *much* shorter or *much* longer than middle pinnae, type of dimorphism, and type of indusium. Experience in keying out a few specimens will soon indicate the procedures that work well for you.

FRONDS

Dimorphism

Fertile and sterile blades similar in shape: not 9-16, 18, 31-36.

Fertile and sterile blades separate and much different but on a common stipe: not 1-8, 17-52 *(leaving only 9-16).*

Fertile and sterile blades much different but on separate stipes: not 1-17, 19-30, 35, 36, 38-41, 43-45, 47-52 *(leaving only 18, 31-34, 37, 42, and 46).*

Fertile pinnae much different in shape from sterile pinnae but on the same blade: not 1-34, 37-41, 43-52 *(leaving only 35, 36, and 42).*

Fertile pinnae slightly different in shape from sterile pinnae and on the same blade: not 1, 3-6, 9-36, 38-41, 43-52 *(leaving only 2, 7, 8, 37, and 42).*

Length (mature leafy blade and stipe)

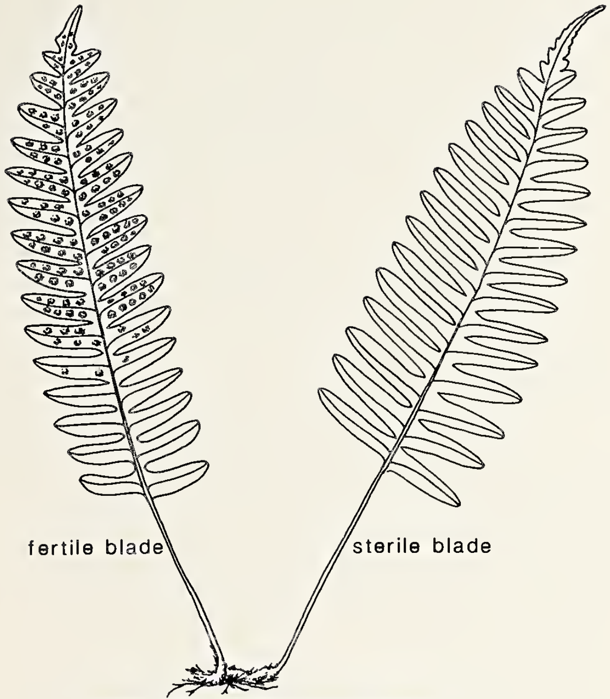
Less than 10 cm long: not 7, 8, 16, 17, 19-24, 26-29, 31-36, 40, 42-47, 51, 52.
10-30 cm long: not 7, 8, 19, 22, 26, 31-36, 40, 47, 52.
30-100 cm long: not 1, 3-5, 11, 15, 17, 18, 41, 48-50.
More than 100 cm long: not 1-6, 9-18, 20, 22, 25, 27, 30, 31, 37-41, 43, 45, 47-51.

Width (mature leafy blade at widest part)

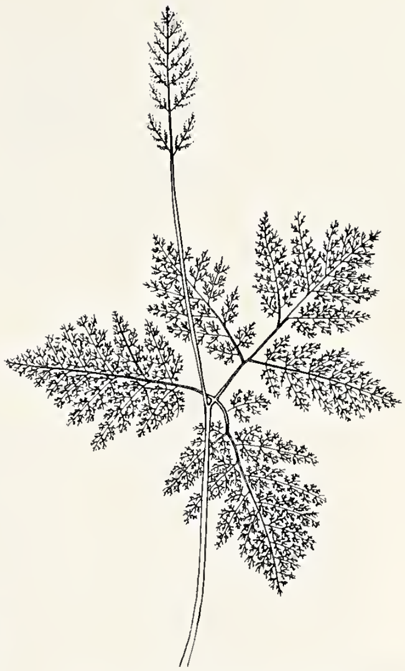
Less than 6 cm wide: not 6-8, 19, 21-24, 26-36, 40, 43-47, 52.
6-20 cm wide: not 3-5, 10-12, 15, 18, 25, 26, 41, 48-50.
20-30 cm wide: not 1-5, 9-12, 15, 17-20, 24, 25, 31, 37, 38, 41-43, 45-51.
More than 30 cm wide: not 1-5, 7-15, 17-21, 23-25, 27-31, 34, 35, 37-39, 41-43, 45-52 *(leaving only 6, 16, 22, 26, 32, 33, 36, 40, and 44).*

Persistence

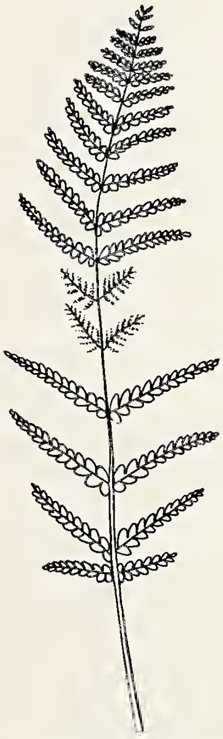
Evergreen: not 6-8, 10-12, 15, 16, 19-22, 30-36, 39, 40, 44-50, 52.
Deciduous: not 1-4, 9, 13, 14, 17, 25, 27, 28, 37, 38, 41, 42.



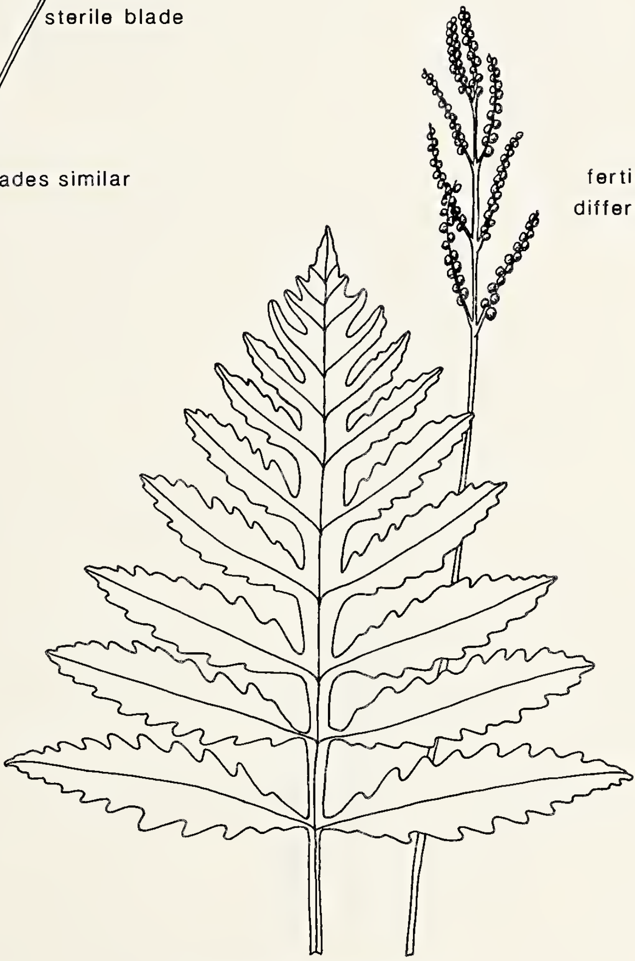
fertile and sterile blades similar



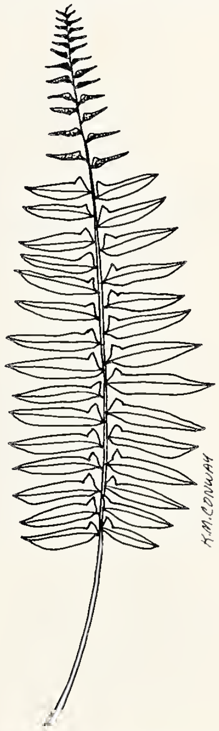
fertile and sterile blades much different but on a common stipe



fertile and sterile pinnae much different but on the same blade



fertile and sterile blades much different but on separate stipes



fertile and sterile pinnae slightly different but on the same blade

LEAFY BLADES

Dissection (lower part of blade)

Ternate: not 1-8, 11, 12, 17-29, 31-43, 45-52 *(leaving only 9, 10, 13-16, 30, and 44).*

Pinnatifid: not 1-14, 16-30, 32, 34-40, 42-52 *(leaving only 15, 31, 33, and 41).*

Once pinnate: not 1, 3, 6, 8-10, 13, 14, 16-30, 32, 34-36, 39, 40, 43-52.

Pinnate-pinnatifid: not 2-7, 11, 13-17, 21, 22, 27, 29-31, 36-38, 43, 44.

Bipinnate: not 2, 4, 5, 7, 11, 16, 27, 30-33, 39, 41, 42, 44, 48, 49.

Bipinnate-pinnatifid: not 2, 4, 5, 7, 8, 10-12, 15, 24, 31-39, 41-43, 45-50, 52.

Tripinnate: not 1-5, 7, 8, 10-12, 15, 19, 21, 23-26, 28, 31-43, 45-52.

Tripinnate-pinnatifid: not 1-8, 10-12, 15-17, 19-29, 31-43, 45-52 *(leaving only 9, 13, 14, 18, 30, and 44).*

Quadripinnate: not 1-8, 10-12, 14-17, 19-52 *(leaving only 9, 13, and 18).*

Length (mature blade)

Less than 4 cm long: not 1, 2, 4, 6-8, 14, 16, 17, 19-47, 49-52 *(leaving only 3, 5, 9-13, 15, 18, and 48).*

4-10 cm long: not 7, 8, 19, 21-24, 26-29, 31, 32, 34-36, 40, 42-45, 47, 51, 52.

10-20 cm long: not 7, 8, 10-12, 14, 15, 19, 22, 23, 26-28, 34-36, 43, 45, 49, 52.

20-50 cm long: not 1, 3, 5, 9-15, 18, 30, 48-50.

50-80 cm long: not 1-5, 9-18, 20, 25, 27, 30, 31, 33, 37-41, 45-51.

More than 80 cm long: not 1-20, 22-31, 33, 37-42, 45-52 *(leaving only 21, 32, 34-36, 43, and 44).*

Ternate: blade divided into three nearly equal parts

Pinnatifid: blade dissected more than half way but not all the way to the midvein

Pinnate: blade dissected to the midvein (rachis) but pinnae not deeply lobed

Pinnate-pinnatifid: blade dissected to the rachis forming pinnae which are deeply lobed

Bipinnate: blade with pinnae dissected to form pinnules, the pinnules with entire or toothed margins but not deeply lobed

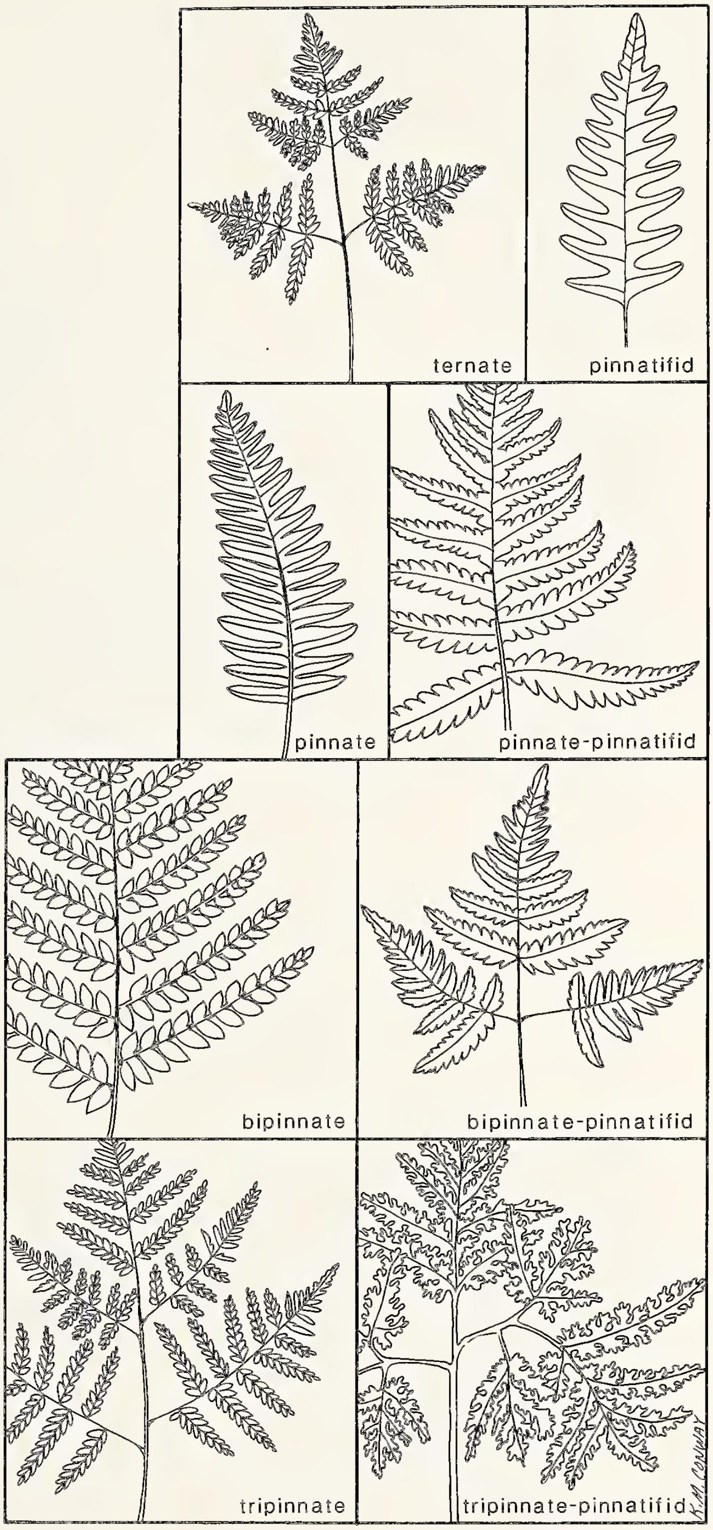
Bipinnate-pinnatifid: blade twice fully dissected with pinnules deeply lobed

Tripinnate: blade three times dissected forming pinnae, pinnules, and pinnulets

Tripinnate-pinnatifid: blade with pinnae, pinnules, and pinnulets, the latter deeply lobed

Quadripinnate: similar to tripinnate-pinnatifid but with the pinnulets dissected all the way to the midvein

Length: from base of blade (upper part of stipe) to tip



STIPES (of leafy blades)

Length

About ¼ or less as long as blade: not 1, 3, 6-8, 10-12, 15, 16, 18, 20-24, 26, 27, 29-31, 33, 36-41, 46, 47, 50, 52.

About ½ as long as blade: not 2, 4, 5, 10-12, 15, 16, 18, 25, 26, 29-33, 36, 39, 40, 43, 45, 47, 52.

About ¾ as long as blade: not 2, 4, 5, 10, 12, 16, 18, 19, 25, 30, 32-35, 39, 40, 42, 43, 45, 52.

About same length as blade: not 2, 4, 5, 7, 8, 10, 12, 17, 19, 21, 25, 28, 32-35, 37, 38, 42, 43, 45, 48, 49, 51, 52.

At least 1½ times as long as blade: not 1, 2, 4-8, 17, 19-29, 31, 32, 34-38, 41-43, 45, 48-52.

Hairs

With hairs above the middle: not 1, 3-6, 10, 11, 18-20, 22-24, 26, 28-31, 33, 36, 41, 42, 44, 47, 49, 52.

Without hairs above the middle: not 17, 27, 37, 39, 50.

Scales

With scales above the middle: not 1, 3, 9-21, 30, 34-36, 38, 41, 44, 45, 47, 49, 52.

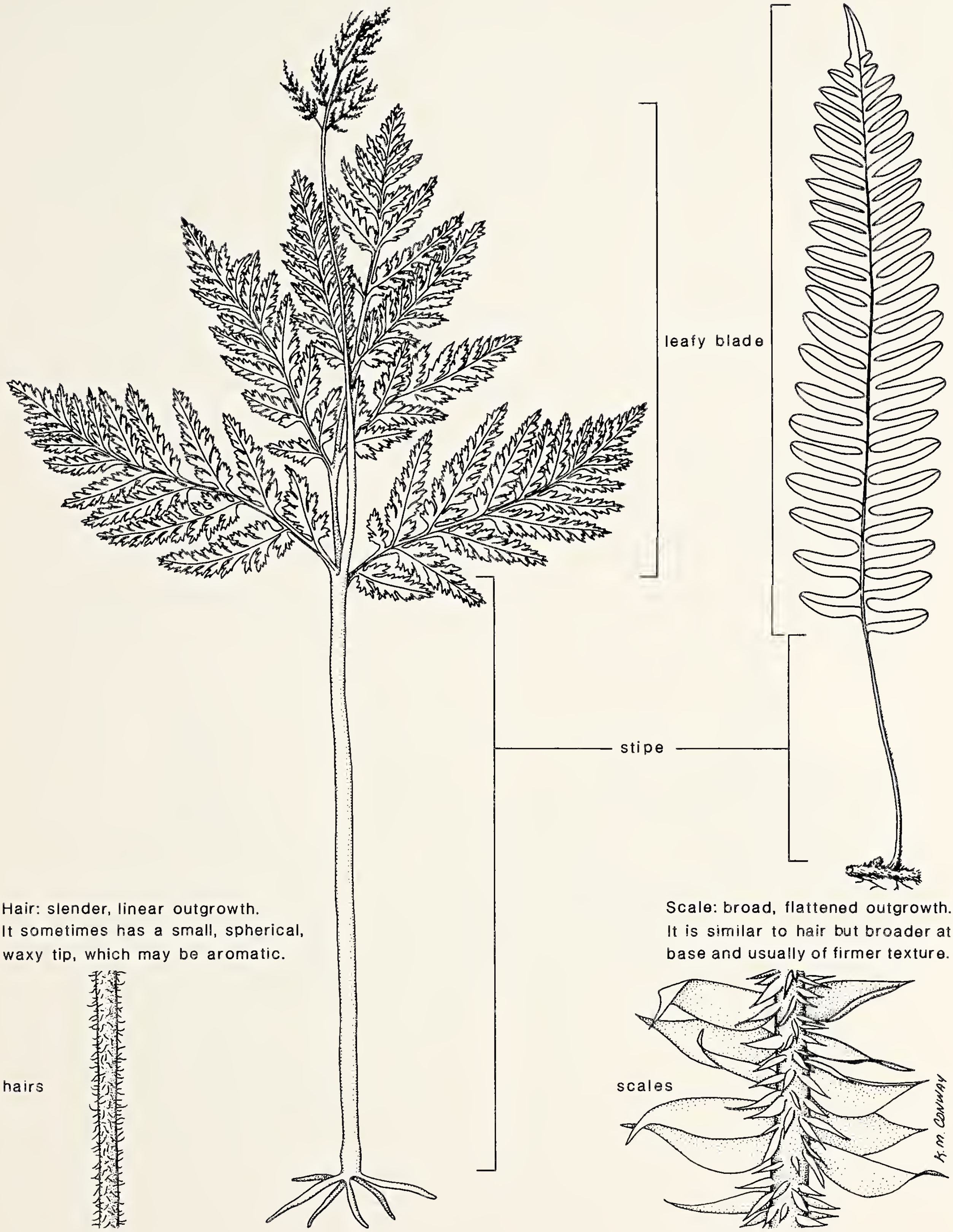
Without scales above the middle: not 22, 25-29, 39, 42, 43, 50, 51.

Color (fresh specimens)

Greenish above the middle: not 2, 4, 17, 19, 22-29, 33, 37-40, 44.

Brown, straw-colored, or yellowish above the middle: not 1, 3, 5-8, 18, 32, 42, 45, 46.

Reddish, purplish, or blackish above the middle: not 1, 3, 5, 7, 8, 10-15, 18, 20, 22-30, 32, 33, 39-49, 51.



Hair: slender, linear outgrowth.
It sometimes has a small, spherical,
waxy tip, which may be aromatic.

Scale: broad, flattened outgrowth.
It is similar to hair but broader at
base and usually of firmer texture.

Bundles at Base of Stipe

With 1 circular or slightly curved or V-shaped or X-shaped bundle: not 6-16, 19, 20, 22-36, 39-47, 52.

With 1 horseshoe-shaped bundle strongly curled in at the ends: not 1-33, 37-52 *(leaving only 34, 35, and 36).*

With 1 horseshoe-shaped bundle not curled in at the ends: not 1-8, 16-20, 22-36, 39-52 *(leaving only 9-15, 21, 37, and 38).*

With 2 circular bundles: not 6-16, 18, 21-29, 32-38, 42-45, 47, 52.

With 2 oval, oblong, or linear bundles: not 18, 21-29, 34-38, 41-44, 52.

With 2 bundles of any shape: not 18, 21-29, 34-38, 42-44, 52.

With 3-9 all circular bundles: not 1-21, 30-40, 44-51 *(leaving only 22-29, 41-43, and 52).*

With 3-9 bundles (at least some linear): not 1-8, 17-42, 45-51 *(leaving only 9-16, 43, 44, and 52).*

With 10 or more bundles: not 1-43, 45-52 *(leaving only 44).*

PINNAE OF LEAFY BLADES

Number (below the pinnatifid apex)

With 1-4 pairs: not 1, 2, 4-8, 16, 17, 19-32, 34, 35, 37-52.

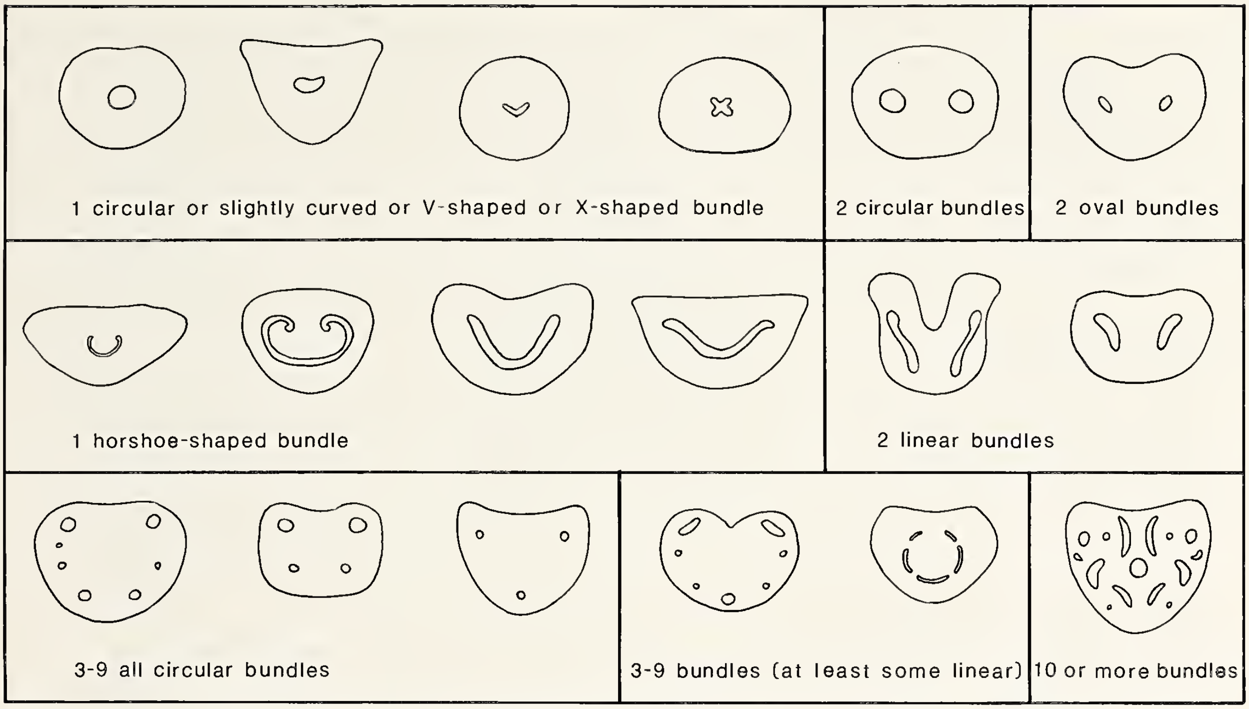
With 5-8 pairs: not 2, 4-8, 17, 19-29, 32, 34, 35, 39, 40, 42, 43, 45-47, 52.

With 9-14 pairs: not 2, 3, 6-10, 12-15, 18, 19, 21, 32, 43, 45, 47, 52.

With 15-24 pairs: not 1, 3, 9-15, 18, 30, 31, 36-38, 40.

With 25-34 pairs: not 1, 3, 5, 8-18, 20, 22-24, 28, 30, 31, 33, 36-38, 40, 41, 44, 48-52.

With 35 or more pairs: not 1, 3-5, 7-18, 20, 22-24, 27-31, 33-41, 44, 48-52.

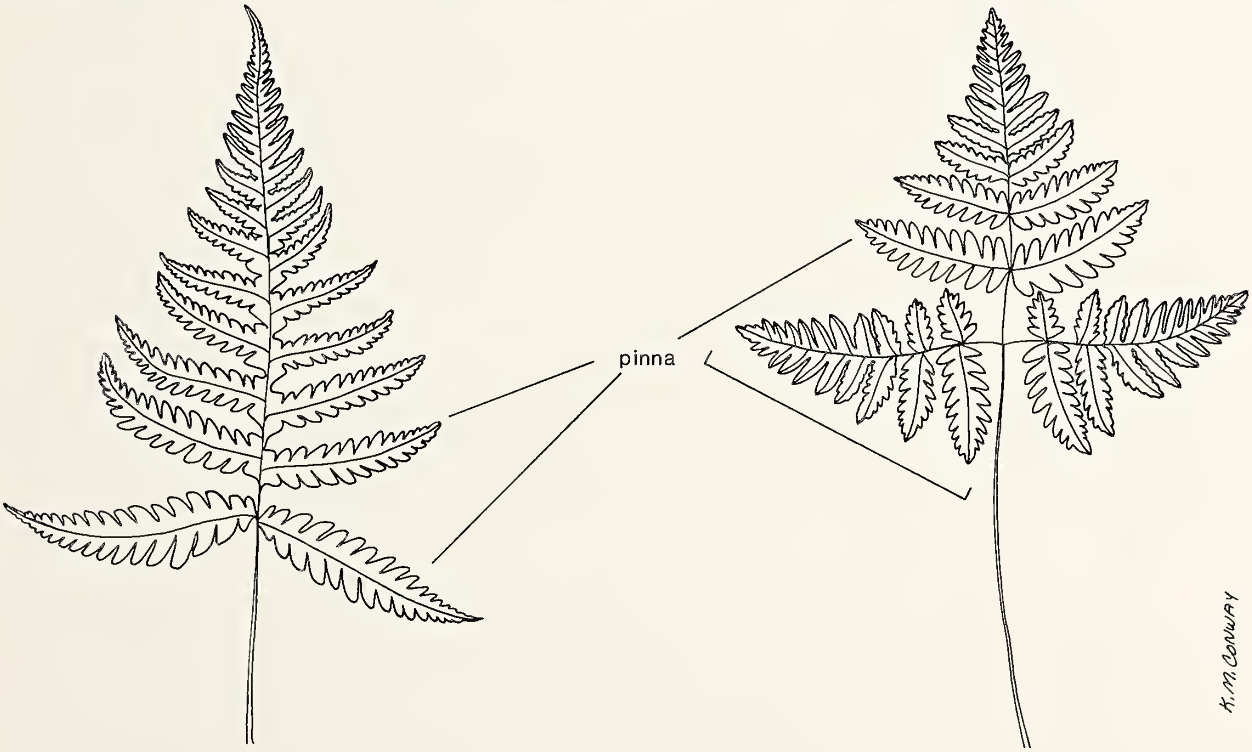


Bundle: group of specialized cells (conducting tubes and fibers) that, in cross-section, appear much different from the surrounding tissue. Do not confuse with cavities that may be present.

Linear: longer than wide, at least 1.5 times.

Oval: slightly longer than wide.

Pinna (pinnae): primary division of a dissected blade. It may be undivided or divided one or more times.



Length of Lowest Pinnae

About ¼ or less as long as middle pinnae: not 1, 3-5, 9-24, 26-31, 33-42, 44, 46-52 *(leaving only 2, 6-8, 25, 32, 43, and 45).*

About ½ as long as middle pinnae: not 1, 3-5, 9-23, 26-33, 36-47, 50, 52 *(leaving only 2, 6-8, 24, 25, 34, 35, 48, 49, and 51).*

About ¾ as long as middle pinnae: not 1-3, 10, 12-14, 16-19, 22, 25, 30-33, 37-40, 43-45.

About same length as middle pinnae: not 2, 7, 8, 24, 25, 32, 43, 45.

At least 1½ times as long as middle pinnae: not 2, 4, 5, 7, 8, 11, 17, 18, 20-29, 31-36, 41-43, 45-52.

Position of Lowest Pinnae

Opposite or nearly so: not 3, 31, 32.

Alternate: not 5, 10-17, 30, 33, 36-40, 42, 44.

Attachment of Lowest Pinnae

Sessile with a broad attachment: not 1, 3-10, 13, 14, 16-30, 32-38, 42-52 *(leaving only 2, 11, 12, 15, 31, 39, 40, and 41).*

Sessile with a narrow attachment: not 2, 3, 22-24, 26, 27, 29, 30, 33, 36, 37, 41, 44.

With a stalk: not 2, 4, 5, 8, 11, 12, 31, 32, 39-41, 45, 47-50, 52.

Leafy Margin

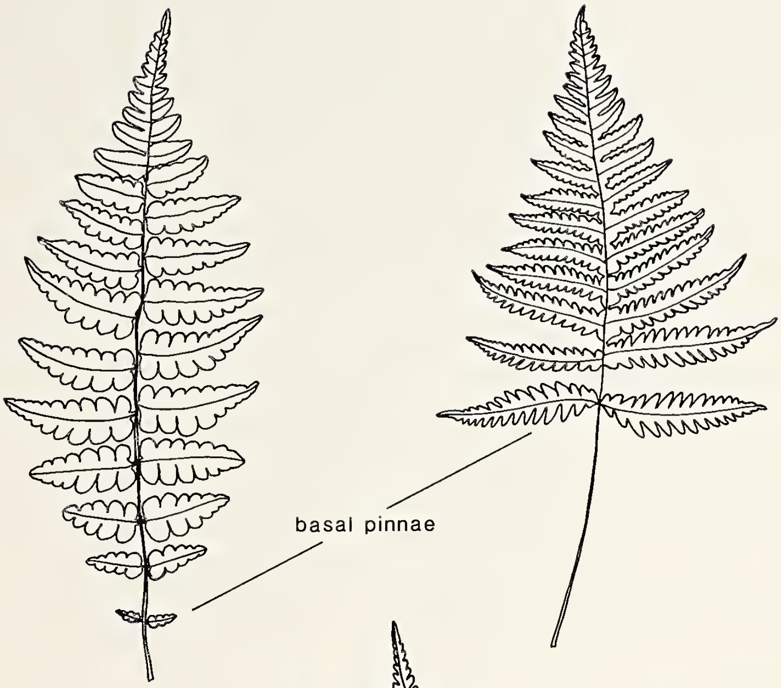
Entire (may be lobed): not 1, 2, 5, 16, 19-27, 29, 42, 43, 51.

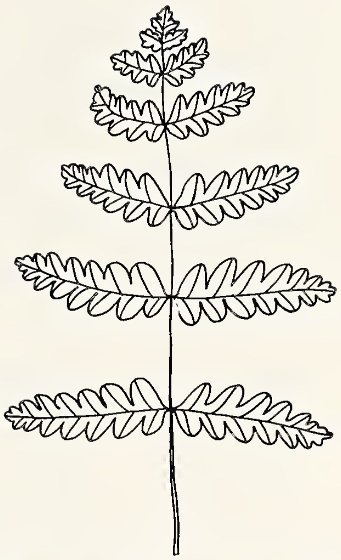
Ciliate: not 1-38, 41-44, 46-52 *(leaving only 39, 40, and 45).*

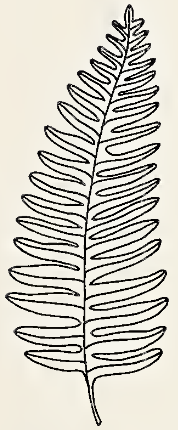
With tiny teeth: not 1, 5, 7, 10, 12, 15, 17, 22, 26, 27, 29, 33-35, 37-40, 42-44, 47, 48.

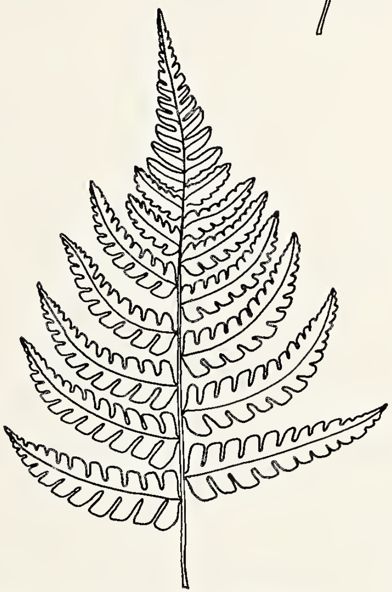
With large teeth but not bristle-tipped: not 3, 7-10, 12, 15, 17, 19, 20, 22, 27-29, 31-50, 52.

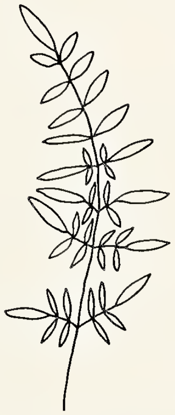
With bristle-tipped teeth: not 1-21, 25, 28, 30-41, 44-52 *(leaving only 22, 23, 24, 26, 27, 29, 42, and 43).*

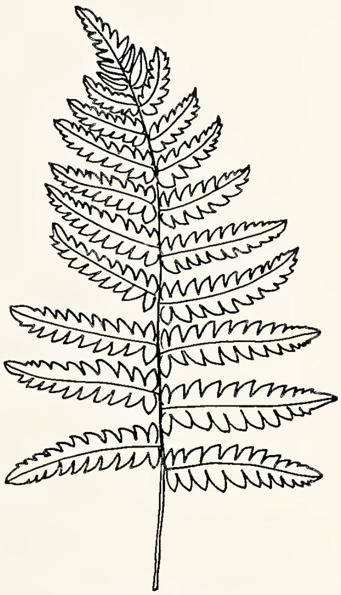


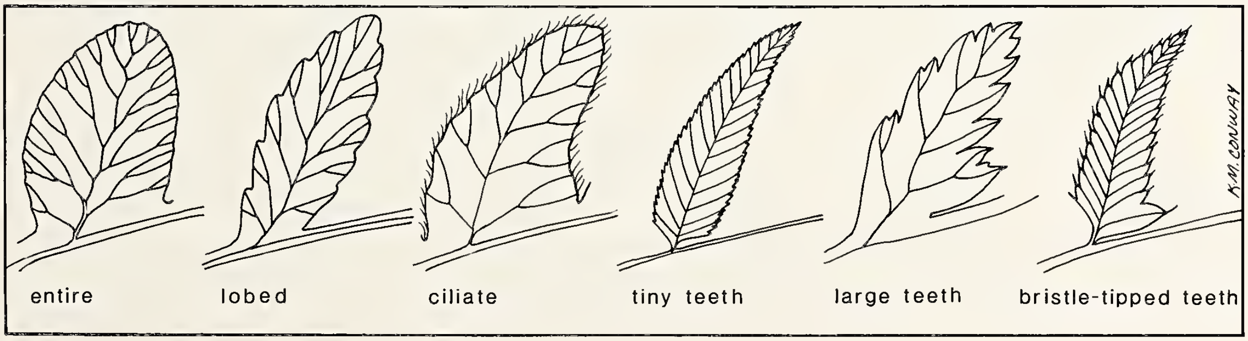

lowest pair of pinnae opposite


lowest pair of pinnae broadly sessile


lowest pair of pinnae narrowly sessile


lowest pair of pinnae with a stalk


lowest pair of pinnae alternate


entire

lobed

ciliate

tiny teeth

large teeth

bristle-tipped teeth

VEINS (from a midvein)

Branching

Mostly reticulate: not 1-30, 32, 34-51 *(leaving only 31, 33, and 52).*

Not reticulate and mostly not forked: not 2, 4, 6, 7, 9-15, 17, 18, 22-24, 26-29, 31, 33-36, 41-44, 48-52.

Not reticulate and mostly forked only once: not 8, 30-33, 44, 47.

Not reticulate and mostly forked two or more times: not 2, 4, 8, 25, 30-35, 39, 45, 47.

Ending

Extend to the margin: not 1-5, 21, 41, 48-51.

Mostly end before the margin, usually with enlarged tips: not 6-16, 19, 20, 30-40, 42-47, 52.

SORI ON LEAFY BLADES

Shape

Circular: not 1-16, 31-36, 44, 52.

Linear: not 9-16, 19-30, 32-36, 39-43, 45-51.

Position

Marginal or nearly so: not 1-16, 19, 22-27, 29, 31-36, 42, 43, 47, 52.

Not marginal: not 9-16, 18, 21, 28, 30, 32-38, 44.

INDUSIA ON LEAFY BLADES

Peltate: not 1-41, 44-52 *(leaving only 42 and 43).*

Reniform: not 1-5, 7-21, 30-44, 48-52 *(leaving only 6, 22-29, 45, 46, and 47).*

Peltate or reniform: not 1-5, 7-21, 30-41, 44, 48-52.

Cuplike or hoodlike: not 1-18, 22-47, 52 *(leaving only 19-21 and 48-51).*

Raylike: not 1-47, 52 *(leaving only 48-51).*

Laterally attached but not at the pinna margin: not 9-18, 21-30, 32-51.

Only the reflexed margin: not 1-16, 19-36, 39-43, 45-52 *(leaving only 17, 18, 37, 38, and 44).*

SPORES

Shape

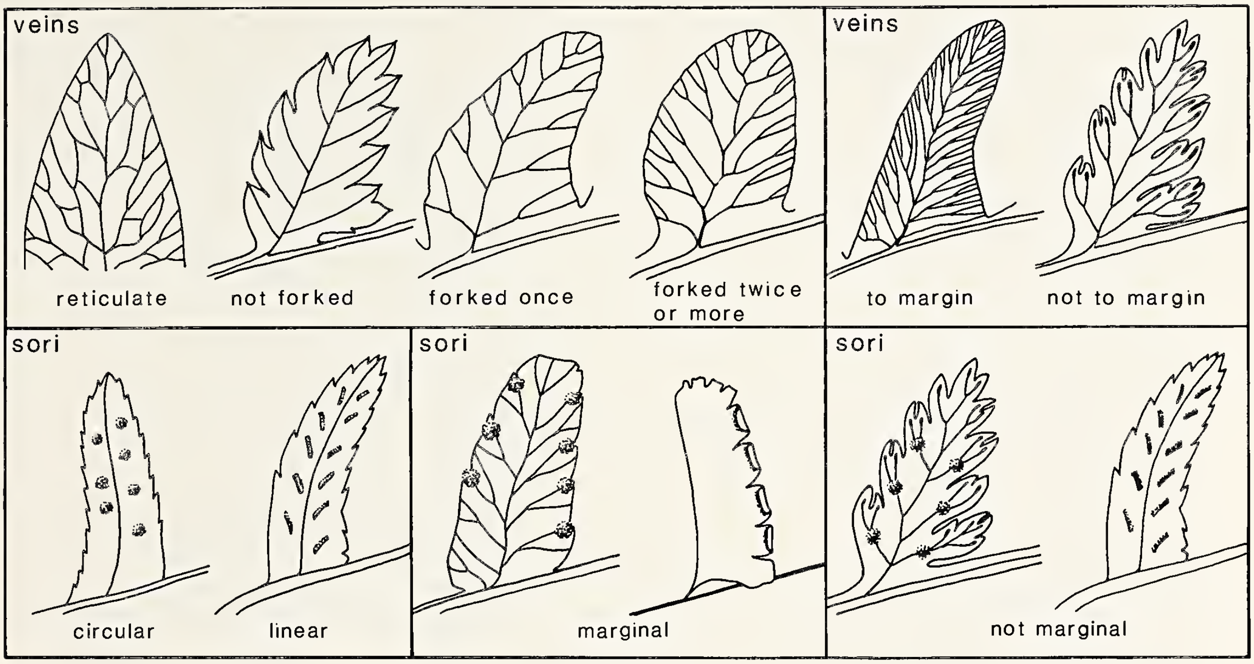
Plano-convex: not 9-18, 21, 34-38, 44.

Circular or triangular: not 1-8, 19, 20, 22-33, 39-43, 45-52.

Surface

Spiny: not 1-18, 21-52 *(leaving only 19 and 20).*

Not spiny: not 19, 20.



Sorus (sori): area where the spores are formed.

Linear: longer than wide, at least 1.5 times the width.

Indusium (indusia): a pale covering over or around a sorus.

Peltate: umbrella-like, circular on top with a central stalk.

Reniform: kidney-shaped, similar to peltate but with a notch or sinus.

Cuplike: attached at base and surrounding the sorus.

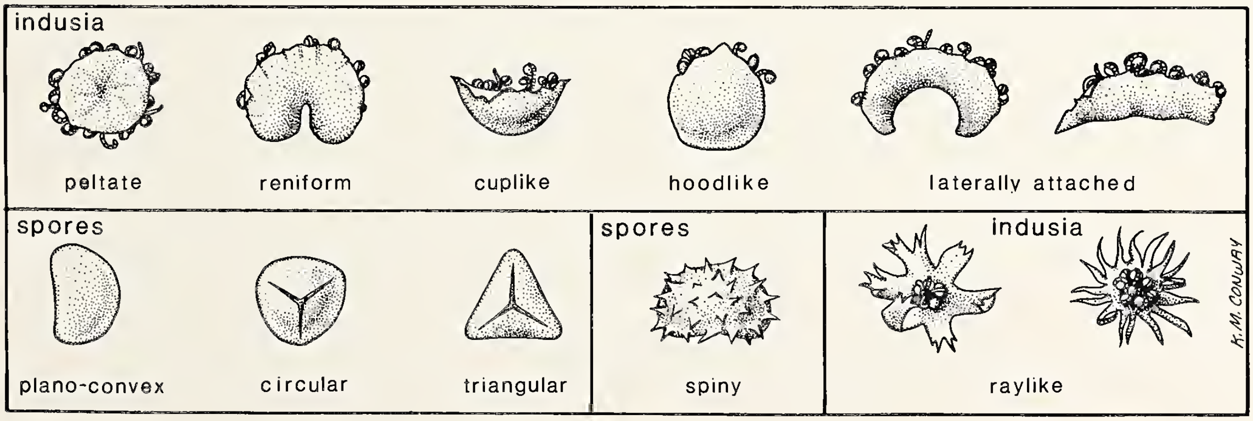
Hoodlike: arching over the sorus in a bladder-like fashion.

Laterally attached: attached at one side only.

Raylike: similar to cuplike but splitting into broad or slender structures.

Reflexed margin: no true indusium, sori partly covered by the inrolled margin of the leafy blade.

Spore: a single-celled reproductive body.



Species numbers for random access key

1	Asplenium montanum
2	Asplenium platyneuron
3	Asplenium ruta-muraria
4	Asplenium trichomanes
5	Asplenium viride
6	Athyrium filix-femina
7	Athyrium pycnocarpon
8	Athyrium thelypterioides
9	Botrychium dissectum
10	Botrychium lanceolatum
11	Botrychium lunaria
12	Botrychium matricariifolium
13	Botrychium multifidum
14	Botrychium oneidense
15	Botrychium simplex
16	Botrychium virginianum
17	Cheilanthes lanosa
18	Cryptogramma stelleri
19	Cystopteris bulbifera
20	Cystopteris fragilis
21	Dennstaedtia punctilobula
22	Dryopteris campyloptera
23	Dryopteris clintoniana
24	Dryopteris cristata
25	Dryopteris fragrans
26	Dryopteris goldiana
27	Dryopteris intermedia
28	Dryopteris marginalis
29	Dryopteris spinulosa
30	Gymnocarpium dryopteris
31	Lorinseria areolata
32	Matteuccia struthiopteris
33	Onoclea sensibilis
34	Osmunda cinnamomea
35	Osmunda claytoniana
36	Osmunda regalis
37	Pellaea atropurpurea
38	Pellaea glabella
39	Phegopteris connectilis
40	Phegopteris hexagonoptera
41	Polypodium virginianum
42	Polystichum acrostichoides
43	Polystichum braunii
44	Pteridium aquilinum
45	Thelypteris noveboracensis
46	Thelypteris palustris
47	Thelypteris simulata
48	Woodsia alpina
49	Woodsia glabella
50	Woodsia ilvensis
51	Woodsia obtusa
52	Woodwardia virginica

KEYS TO GROUPS OF SPECIES WITH DISSECTED FRONDS

The eight species illustrated under FERNS WITHOUT FERNLIKE DISSECTED FRONDS (page 3) are not included in these keys.

To use the keys, choose two characters among the 18 listed on the next page. Follow, as in the familiar mileage chart, to the box which gives the proper key number. For example: if you choose leafy blades pinnate and stipes with three to nine all circular bundles you are referred to KEY 24. Mostly the lower the key number the fewer species in the key. These keys are in numerical order and rapidly located. They are of the dichotomous kind found in many identification manuals. Here you determine which one of the first pair (couplet number 1) most nearly describes the specimen. The statement that is chosen will lead to a species name or to a group of species in a genus or to another pair of statements or to another key.

The combination that is chosen reduces the number of possible species anywhere from 1 to 18 of the 52 species involved. Whenever possible, it usually is wise to choose a combination having few species (a low key number). But do not guess. Make sure the characters chosen agree with the fern to be identified. It is nearly always possible to choose more than one combination leading to different keys, some of which may be easier to use than others.

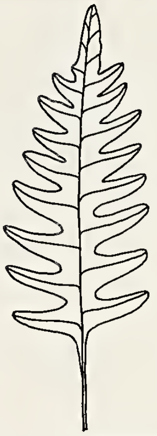
If a key leads to a genus, refer to the KEYS TO SPECIES WHEN GENUS IS KNOWN, where the genera are listed in alphabetical order.

When the specimen exhibits insufficient characters for making a decision as to which leg of a dichotomous key to choose, it may be necessary to try both legs and compare the end results with the illustrated descriptions or refer to the RANDOM ACCESS KEY TO SPECIES WITH DISSECTED FRONDS.

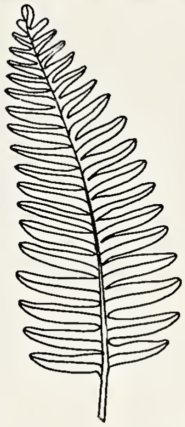
KEYS TO GROUPS OF SPECIES WITH DISSECTED FRONDS

Choose two characters to determine the key number.

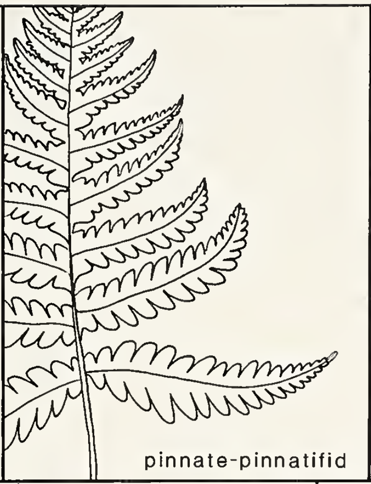
	Leafy blades pinnatifid	Leafy blades pinnate	Leafy blades pinnate-pinnatifid	Leafy blades bipinnate	Leafy blades bipinnate-pinnatifid	Leafy blades tripinnate	Leafy blades tripinnate-pinnatifid or quadripinnate	Stipes at base with one small bundle	Stipes at base with one large horshoe-shaped bundle	Stipes at base with two circular bundles	Stipes at base with two linear bundles	Stipes with three to nine all circular bundles	Stipes with three to many (some or all linear) bundles	Sori on leafy blades circular and marginal	Sori on leafy blades circular and not marginal	Sori on leafy blades linear and marginal	Sori on leafy blades linear and not marginal
Leafy blades pinnate																	
Leafy blades pinnate-pinnatifid																	
Leafy blades bipinnate																	
Leafy blades bipinnate-pinnatifid																	
Leafy blades tripinnate																	
Leafy blades tripinnate-pinnatifid or quadripinnate																	
Stipes at base with one small bundle		52	62	63	39	13	3										
Stipes at base with one large horshoe-shaped bundle	1	55	60	83	44	47	30										
Stipes at base with two circular bundles	6	51	77	70	64	40	4										
Stipes at base with two linear bundles	32	74	91	90	84	65	30										
Stipes with three to nine all circular bundles	6	24	69	76	61	37											
Stipes with three to many (some or all linear) bundles	1	31	42	67	54	54	46										
Sori on leafy blades circular and marginal	6	38	87	87	87	34	15	68	36	80	72	19					
Sori on leafy blades circular and not marginal	6	24	89	88	88	58		56		79	85	75					
Sori on leafy blades linear and marginal		23	35	48	33	33	17	49	23	2	2		9				
Sori on leafy blades linear and not marginal	5	50	27	49	40	12		57		59	73	10	10				
Dimorphic fronds	31	71	81	82	53	47	43	28	78	29	86	7	66	16	25	16	41



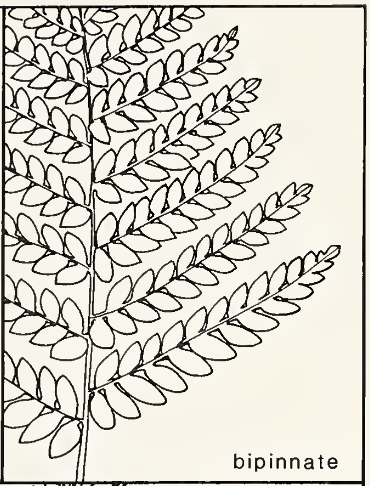
pinnatifid



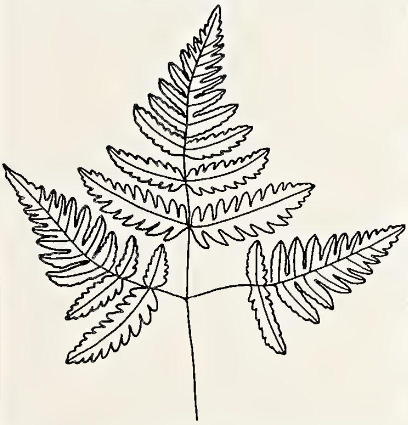
pinnate



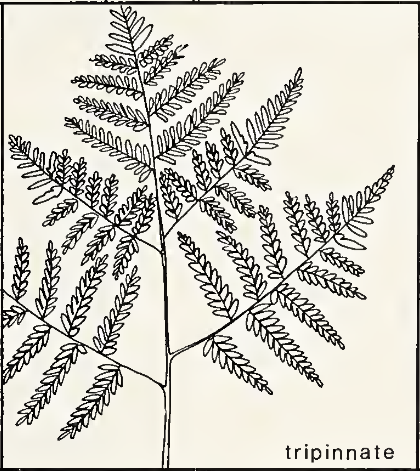
pinnate-pinnatifid



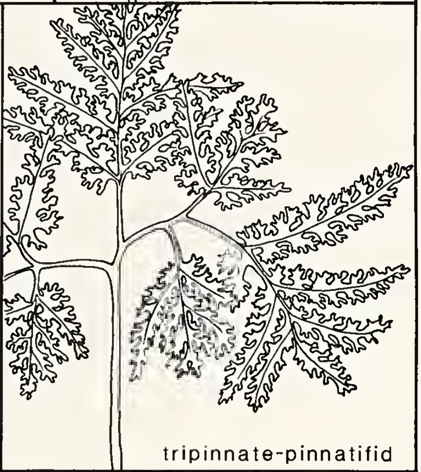
bipinnate



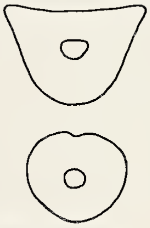
bipinnate-pinnatifid



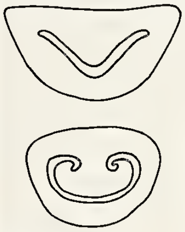
tripinnate



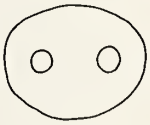
tripinnate-pinnatifid



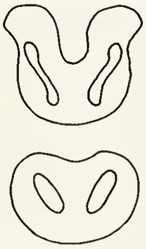
stipe with 1 small bundle



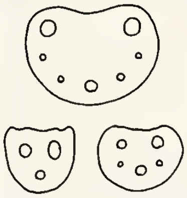
stipe with 1 horshoe-shaped bundle



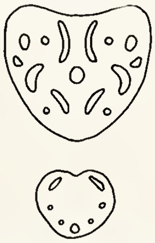
stipe with 2 circular bundles



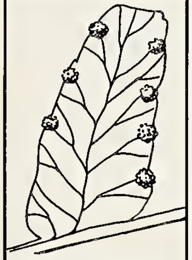
stipe with 2 linear bundles



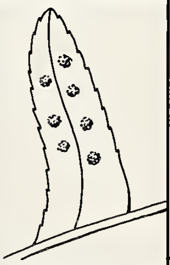
stipe with 3-9 all circular bundles



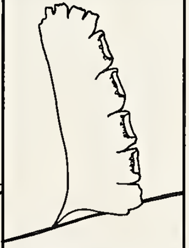
stipe with 3-many, some linear, bundles



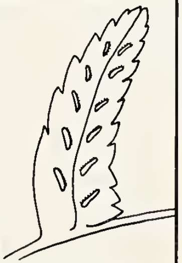
sori circular and marginal



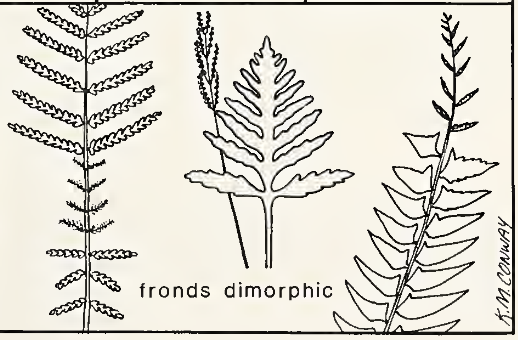
sori circular not marginal



sori linear and marginal



sori linear not marginal



fronds dimorphic

KEY 1

. . . . *Botrychium simplex*

KEY 2

. . . . *Cheilanthes lanosa*

KEY 3

. . . . *Cryptogramma stelleri*

KEY 4

. . . . *Gymnocarpium dryopteris*

KEY 5

. . . . *Lorinseria areolata*

KEY 6

. . . . *Polypodium virginianum*

KEY 7

. . . . *Polystichum acrostichoides*

KEY 8

. . . . *Polystichum braunii*

KEY 9

. . . . *Pteridium aquilinum*

KEY 10

. . . . *Woodwardia virginica*

KEY 11

1. Stipes green throughout, slender; blades with 2-6 pairs of pinnae; veins of pinnules fanlike. . . . . *Asplenium ruta-muraria*
1. Stipes brown at base, green above; blades with 5-12 pairs of pinnae; veins obscure . . . . *Asplenium montanum*

KEY 12

1. Stipes and rachises glabrous or with a few hairs, with scales; fronds usually 40-90 cm long; sori linear, usually curved; indusia laterally attached . . . . *Athyrium filix-femina*
1. Stipes and rachises densely covered with brownish hairs, without scales; fronds usually 10-30 cm long; sori circular to oblong; indusia only the reflexed, unmodified, green margin of the pinnule . . . . *Cheilanthes lanosa*

KEY 13

1. Stipes and rachises densely covered with brownish hairs; fronds not dimorphic, with 12-20 pairs of pinnae . . . . *Cheilanthes lanosa*
1. Stipes hairy only at base, glabrous above, rachises glabrous; fronds dimorphic; sterile fronds with 5 or 6 pairs of pinnae . . . . *Cryptogramma stelleri*

KEY 14

1. Stipes and rachises densely covered with brownish hairs; blades less than 10 cm long; stipes with 1 or 2 bundles . . . . *Cheilanthes lanosa*
1. Stipes and rachises glabrous; blades more than 20 cm long; stipes with more than 8 bundles . . . . *Pteridium aquilinum*

KEY 15

1. Fronds dimorphic; blades not ternate; stipes with 1 bundle . . . . *Cryptogramma stelleri*
1. Fronds not dimorphic; blades ternate, each third triangular; stipes with 2 bundles . . . . *Gymnocarpium dryopteris*

KEY 16

1. Blades bipinnate to quadripinnate (rarely only pinnate-pinnatifid), mostly less than 8 cm long and 5 cm wide; pinnule margins dentate or crenate, stipes weak, greenish . . . . . *Cryptogramma stelleri*
1. Blades pinnate above to bipinnate below, mostly more than 10 cm long and 5 cm wide; pinnule margins entire; stipes wiry, purplish or reddish or nearly black, shiny . . . . *Pellaea atropurpurea*

KEY 17

1. Blades less than 10 cm long; first division not ternate; stipes with 1 bundle . . . . *Cryptogramma stelleri*
1. Blades more than 20 cm long; first division usually ternate; stipes with several bundles . . . . *Pteridium aquilinum*

KEY 18

1. Fronds with hairs on stipe, rachis, and indusia; the second pinnule from the rachis on the lower side of the lowest pinna usually the longest. . . . . *Dryopteris intermedia*
1. Fronds without hairs; the pinnule closest to the rachis on the lower side of the lowest pinna longer than the other pinnules . . . . *Dryopteris spinulosa*

KEY 19

1. Stipes densely scaly, with 3-9 bundles at base and upward; indusia reniform . . *Dryopteris marginalis*
1. Stipes without scales above the middle, with 3 bundles at extreme base, soon becoming 2 and then 1 upward; indusia absent. . . . . *Polypodium virginianum*

KEY 20

1. Pinnae alternate; margins serrulate; fertile pinnae bladelike; sori linear . . . . *Lorinseria areolata*
1. Pinnae opposite or mostly so; margins entire; fertile pinnae resemble strings of beads; sori spherical . . . . *Onoclea sensibilis*

KEY 21

1. Fronds dimorphic; veins mostly reticulate. . . . . *Lorinseria areolata*
1. Fronds not dimorphic; veins not reticulate . . . . *Polypodium virginianum*

KEY 22

1. Fertile and sterile pinnae on separate blades; sterile pinnae (when young) with tuft of hairs at base . . . . *Osmunda cinnamomea*
1. Fertile and sterile pinnae on the same blade; sterile pinnae without tuft of hairs at base . . . . *Osmunda claytoniana*

KEY 23

. . . . species of *Pellaea*

KEY 24

1. Stipes without scales above the middle, with 2 or 3 bundles at base . . . . *Polypodium virginianum*
1. Stipes densely scaly, with 4 or 5 bundles at base . . . . *Polystichum acrostichoides*

KEY 25

1. Stipes densely scaly; pinnae auricled, margins with bristle-tipped teeth; stipes with 4 or 5 bundles at base . . . . *Polystichum acrostichoides*
1. Stipes with a few scales when young; pinnae without an auricle; margins entire or shallowly toothed; stipes with 2 bundles at base. . . . . *Thelypteris palustris*

KEY 26

1. Stipes and rachises with many hairs and scales; stipes with a joint at or below the middle (old stipe bases rather uniform in length); indusia with many hairlike rays . . . . *Woodsia ilvensis*
1. Stipes and rachises with a few hairs and scales; stipes not jointed (old stipe bases uneven in length); indusia with 3–6 short scalelike rays . . . . *Woodsia obtusa*

KEY 27

1. Veins mostly free but reticulate along the midvein; stipes with 5-9 bundles at base; sori in chainlike rows along the midveins . . *Woodwardia virginica*
1. Veins all free; stipes with 2 bundles at base; sori scarcely in chainlike rows 2
    2. Pinnae 15-20 pairs per blade, sessile, lowest pair shorter than middle pinnae and usually pointing downward; stipes with 2 linear bundles at base . . . . *Athyrium thelypterioides*
    2. Pinnae 5-12 pairs per blade, stalked, lowest pair usually longer than middle pinnae; stipes with 1 or 2 circular or oval bundles at base . . . . *Asplenium montanum*

KEY 28

1. Blades pinnate; pinnae of sterile blades 15-25, lowest much shorter than middle pinnae; rachises dark brown, shiny, with scales . . . . *Asplenium platyneuron*
1. Blades mostly bipinnate, at least below; pinnae of sterile blades 5-11, lowest as long or longer than middle pinnae; rachises without scales, glabrous or with rough hairs . . . . KEY 16

KEY 29

1. Veins mostly reticulate . . . . *Lorinseria areolata*
1. Veins not reticulate 2
    2. Blades pinnate; rachises with scales; lowest pair of pinnae much shorter than middle pinnae; sori short-linear; indusia laterally attached. . . . . *Asplenium platyneuron*
    2. Blades pinnate-pinnatifid to bipinnate; rachises with tiny hairs; lowest pair of pinnae about same length or slightly shorter than middle pinnae; sori circular; indusia reniform, often circular but with a sinus . . . . . *Thelypteris palustris*

KEY 30

1. Sterile blades thick, leathery or fleshy; pinnule segments of similar size and shape and mostly about twice as long as wide with ultimate lobes or teeth not parallel-sided and mostly obtuse at apex; terminal segments not elongate .... *Botrychium multifidum*
1. Sterile blades thin or slightly leathery; pinnule segments variable in size and shape; terminal segments elongate 2
   2. Sterile blades sometimes lacelike in appearance; pinnule segments usually more than twice as long as wide with ultimate lobes or teeth somewhat parallel-sided and mostly acute at apex .. .. *Botrychium dissectum*
   2. Sterile blades not lacelike; pinnule segments about as long as wide with ultimate lobes or teeth mostly obtuse at apex .... *Botrychium oneidense*

KEY 31

1. Common stipe longer than stalk of fertile blade; pinnae not fanlike, not cuneate at base, acute or obtuse at apex ...... *Botrychium matricariifolium*
1. Common stipe shorter to longer than stalk of fertile blade; pinnae fanlike, cuneate at base, rounded at apex 2
   2. Sterile blade sessile or with a stalk less than 1/5 as long as blade, with 3-10 pairs of pinnae that are at a right-angle to the rachis .... *Botrychium lunaria*
   2. Sterile blade with a stalk 1/3 to 1/2 as long as blade, with 1-5 pairs of pinnae that usually are oblique to the rachis ..... *Botrychium simplex*

KEY 32

1. Veins of leafy blades mostly reticulate ...KEY 20
1. Veins of leafy blades mostly free................ .... *Botrychium simplex*

KEY 33

1. Blades less than 8 cm wide; stipes with 1 or 2 bundles ....KEY 13
1. Blades more than 10 cm wide; stipes with more than 8 bundles .... *Pteridium aquilinum*

KEY 34

1. Stipes and rachises densely covered with brownish hairs .... *Cheilanthes lanosa*
1. Stipes and rachises glabrous or nearly so 2
   2. Blades ternate, each third triangular .... *Gymnocarpium dryopteris*
   2. Blades not ternate .... *Cystopteris fragilis*

KEY 35

1. Blades bipinnate to quadripinnate (rarely pinnate-pinnatifid); mostly less than 10 cm long and 5 cm wide; pinnule margins dentate or crenate; stipes weak, greenish .... *Cryptogramma stelleri*
1. Blades pinnate above to bipinnate below; mostly more than 10 cm long and 5 cm wide; pinnule margins entire; stipes wiry, purplish or reddish or nearly black, shiny ....species of *Pellaea*

KEY 36

1. Pinnae more than 15 pairs, with many small whitish gland-tipped hairs, margins serrate; indusia cuplike .... *Dennstaedtia punctilobula*
1. Pinnae fewer than 12 pairs, glabrous or with a few hairs, margins entire; indusia absent but with an indusium-like reflexed margin of the blade....... ....species of *Pellaea*

KEY 37

1. Fronds with short, glandular hairs on stipes, rachis, and indusia; lowest basal pinnule on lower side of lowest pinna shorter than pinnule next above .... *Dryopteris intermedia*
1. Fronds without hairs; lowest basal pinnule on lower side of lowest pinna longer than pinnule next above 2
   2. Basal pair of pinnules of lowest pinnae opposite or nearly so (4 mm or less apart); the lowest basal pinnule about twice as long and slightly wider at base than the opposing basal pinnule .... *Dryopteris spinulosa*
   2. Basal pair of pinnules of lowest pinnae alternate (4 mm or more apart); the lowest basal pinnule two or three times as long and much wider at base than the opposing basal pinnule......... .... *Dryopteris campyloptera*

KEY 38

1. Blades pinnate above to bipinnate below; stipes with 1 linear, curved bundle ...species of *Pellaea*
1. Blades never bipinnate; stipes with 2 or 3 circular bundles at base .... *Polypodium virginianum*

KEY 39

1. Pinnae sessile; sori circular; indusia cuplike when young, raylike with age .... *Woodsia obtusa*
1. Pinnae with stalks, at least the lowest pair; indusia not cuplike or raylike 2
   2. Stipes wiry, densely covered with brownish hairs, without scales; blades with 12-20 pairs of pinnae; indusia only the reflexed margin of the fertile pinnules .... *Cheilanthes lanosa*
   2. Stipes glabrous or with a few hairs at base; blades with 5-12 pairs of pinnae 3
3. Fertile and sterile fronds similar; sori linear, not marginal; indusia laterally attached .... *Asplenium montanum*
3. Fertile fronds longer than sterile fronds; sori marginal; true indusium absent, a false indusium when young opens flat with age .... *Cryptogramma stelleri*

KEY 40

1. Stipes and rachises densely covered with brownish hairs, without scales; indusia only the reflexed, unmodified, green margin of the pinnule .... *Cheilanthes lanosa*
1. Stipes and rachises glabrous or with a few hairs; indusia laterally attached 2
   2. Blades with 2-12 pairs of pinnae; stipes with 2 oval bundles at base; sori usually fewer than 15 per pinna ....KEY 11
   2. Blades with 15-40 pairs of pinnae; stipes with 2 long, linear, curved bundles at base; sori usually more than 20 per pinna.................................... *Athyrium filix-femina*

KEY 41

1. Veins mostly reticulate, only the outer ones free .... *Lorinseria areolata*
1. Veins mostly not reticulate 2
   2. Blades 2-7 cm wide; stipes with 1 or 2 circular or oval bundles at base; sori fewer than 15 per pinna .... *Asplenium platyneuron*
   2. Blades mostly more than 10 cm wide; stipes with 2 linear bundles at base; sori more than 20 per pinna 3
3. Fronds pinnate, margins not lobed; rachises without scales .... *Athyrium pycnocarpon*
3. Fronds pinnate-pinnatifid; rachises with a few scales .... *Athyrium thelypterioides*

KEY 42

1. Fronds dimorphic; sori absent on leafy blades ..2
1. Fronds not dimorphic; sori oblong-linear, forming two rows along the midveins .... *Woodwardia virginica*
   2. Common stipes 0.5-6 cm long, much shorter than stalk of fertile blade; stalks of sterile blades more than 2 cm long ...*Botrychium dissectum*
   2. Common stipes 6-20 cm long, much longer than stalk of fertile blade; stalks of sterile blades less than 2 cm long 3
3. Stalks of sterile blades 0-0.6 cm long; stalks of fertile blades 0.5-1.3 cm long; sterile blades pinnate-pinnatifid or bipinnate ...*Botrychium lanceolatum*
3. Stalks of sterile blades 0.2-1.5 cm long; stalks of fertile blades 1-4 cm long; sterile blades pinnate or pinnate-pinnatifid ....*Botrychium matricariifolium*

KEY 43

1. Fertile and sterile blades with separate stalks but with a common stipe; fertile blades not leaflike; stipes more than 1 mm in diameter, with 1 to several bundles in a nearly closed ring ..KEY 30
1. Fertile and sterile blades on separate stipes, both blades leaflike; stipes less than 1 mm in diameter, with 1 circular or slightly curved bundle .... *Cryptogramma stelleri*

KEY 44

1. Fronds dimorphic with fertile and sterile blades from a common stipe; croziers absent; rachises and pinnae of leafy blades glabrous; sori absent on leafy blades ....KEY 30
1. Fronds not dimorphic; croziers covered with silvery-white, glandular hairs; rachises and pinnae with many small, whitish, gland-tipped hairs; sori on leafy blades ....*Dennsteadtia punctilobula*

KEY 45

1. Fronds dimorphic; leafy blades without sori..KEY 30
1. Fronds not dimorphic; sori on leafy blades............................. *Gymnocarpium dryopteris*

KEY 46

1. Fronds dimorphic; leafy blades less than 30 cm wide; stipe bundles linear and arranged in a ring; sori absent on leafy blades .... KEY 30

1. Fronds not dimorphic; leafy blades usually more than 30 cm wide; stipe bundles of various sizes and shapes and irregularly arranged; sori long-linear, marginal .... *Pteridium aquilinum*

KEY 47

1. Sterile blades with stalk, evergreen or becoming bronze in color; veins mostly forked several times; bud for following year surrounded by base of stipe .... KEY 30
1. Sterile blades sessile or nearly so; not evergreen; veins mostly forked only once; bud for following year exposed at side of base of stipe ....*Botrychium virginianum*

KEY 48

1. Stipes and rachises densely covered with brownish hairs, without scales; with 12-20 pairs of pinnae .. ..*Cheilanthes lanosa*
1. Stipes and rachises glabrous or with a few hairs; with 5-11 pairs of pinnae .... KEY 35

KEY 49

1. Sori in chainlike rows along the midveins; stipes with 5-9 bundles .... *Woodwardia virginica*
1. Sori scarcely in chainlike rows; stipes with 1 or 2 bundles 2
    2. Stipes with hairs or scales above the middle; blades with 12 or more pairs of pinnae....... .... KEY 12
    2. Stipes without hairs or scales above the middle; blades with 12 or fewer pairs of pinnae ....KEY 11

KEY 50

1. Veins mostly reticulate ...... *Lorinseria areolata*
1. Veins free 2
    2. Blades 10 cm or more wide; middle pinnae usually more than 7 times as long as wide; stipes with 2 linear bundles at base; sori usually more than 20 per pinna ....*Athyrium pycnocarpon*
    2. Blades 7 cm wide or less; middle pinnae usually less than 7 times as long as wide; stipes with 2 oval bundles at base; sori usually fewer than 15 per pinna .... species of *Asplenium* (except *A. montanum* and *A. ruta-muraria*)

KEY 51

1. Fronds dimorphic; veins reticulate ....*Lorinseria areolata*
1. Fronds not dimorphic, veins not reticulate 2
    2. Pinnae alternate; sori circular; indusia absent.. ....*Polypodium virginianum*
    2. Sori (at least some) linear or oblong; indusia laterally attached .... species of *Asplenium* (except *A. montanum* and *A. ruta-muraria*)

KEY 52

1. Sori marginal; indusia only the reflexed, unmodified margin of the pinna ...... species of *Pellaea*
1. Sori not marginal; indusia laterally attached...... species of *Asplenium* (except *A. montanum* and *A. ruta-muraria*)

KEY 53

1. Fertile and sterile blades with a common stipe; fertile blades not leaflike; stipes more than 1 mm in diameter, with 1 to several bundles in a nearly closed ring .... KEY 47
1. Fertile and sterile blades on separate stipes, both blades leaflike; stipes less than 1 mm in diameter, with 1 circular or slightly curved bundle ....*Cryptogramma stelleri*

KEY 54

1. Fronds dimorphic; blades less than 40 cm wide; croziers not formed; stipe bundles linear and arranged in a ring; sori absent on leafy blades ....KEY 47
1. Fronds not dimorphic; blades usually more than 35 cm wide; croziers in groups of three on young plants; stipe bundles of various sizes and shapes and irregularly arranged; sori long-linear, marginal ....*Pteridium aquilinum*

KEY 55

1. Fronds strongly dimorphic with fertile and sterile blades on a common stipe; stipes fleshy, greenish; sori absent on leafy blades .... KEY 31
1. Fronds not or slightly dimorphic; stipes wiry, purplish or reddish; sori on leafy blades circular or oblong .... species of *Pellaea*

KEY 56

1. Stipes and rachises densely covered with brownish hairs, without scales; indusia only the reflexed, unmodified, green margin of the pinnule ....*Cheilanthes lanosa*
1. Stipes glabrous or with few to many hairs, scales usually present; true indusia present, at least when young .... species of *Woodsia*

KEY 57

1. Stipes and rachises densely covered with brownish hairs, without scales; indusia only the reflexed, unmodified, green margin of the blade .... *Cheilanthes lanosa*
1. Stipes and rachises glabrous or with a few hairs; indusia laterally attached ....species of *Asplenium*

KEY 58

1. Stipes with 1 or 2 bundles; pinnule margins entire or with small teeth that are not bristle-tipped; indusia absent or laterally attached .... KEY 34
1. Stipes with 3-9 bundles; pinnule margins with large bristle-tipped teeth; indusia reniform, often circular, but with a sinus .... KEY 37

KEY 59

1. Fronds strongly dimorphic; veins of leafy blades reticulate .... *Lorinseria areolata*
1. Fronds not dimorphic or only slightly so; veins not reticulate .... KEY 57

KEY 60

1. Fronds not, or slightly dimorphic; sori on leafy blades; stipes slender, wiry, purplish or reddish.. ....species of *Pellaea*
1. Fronds strongly dimorphic, without sori on leafy blades; stipes 2-5 mm in diameter 2
    2. Fronds less than 40 cm long; fertile and sterile blades separate but on a common stipe; stipe bundle not curled in at the ends; croziers not formed 3
    2. Mature fronds usually more than 50 cm long; fertile and sterile blades on separate stipes, or fertile and sterile pinnae on separate parts of the same blade; stipe bundles strongly curled in at the ends; croziers present on young plants ....KEY 22
3. Common stipe 0.5-6 cm long, much shorter than stalk of fertile blade; stalks of sterile blades more than 2 cm long .... *Botrychium dissectum*
3. Common stipe 6-20 cm long, much longer than stalk of fertile blade; stalks of sterile blades less than 2 cm long 4
    4. Stalk of sterile blades 0-0.6 cm long; stalks of fertile blades 0.5-1.3 cm long; sterile blades pinnate-pinnatifid or bipinnate.............. ....*Botrychium lanceolatum*
    4. Stalks of sterile blades 0.2-1.5 cm long; stalks of fertile blades 1-4 cm long; sterile blades pinnate or pinnate-pinnatifid....................... ....*Botrychium matricariifolium*

KEY 61

.... species of *Dryopteris* (except *D. cristata*)

KEY 62

1. Lowest pinnae sessile or nearly so; sori circular; indusia cuplike when young, raylike with age...... ....species of *Woodsia*
1. Lowest pinnae with short or long stalks; indusia not cuplike or raylike 2
    2. Sori marginal or nearly so; true indusium absent, sori may be covered by the reflexed margins of the pinnae .... KEY 35
    2. Sori linear, not marginal; indusia laterally attached .... *Asplenium montanum*

KEY 63

1. Sori marginal; indusia only the reflexed margin of the pinnules .... KEY 48
1. Sori not marginal; indusia laterally attached or cuplike or raylike 2
    2. Sori linear; indusia laterally attached ....KEY 11
    2. Sori circular; indusia cuplike or raylike ....KEY 26

KEY 64

1. First division of blade ternate, each of the three divisions triangular; stipe bundles free to the base of the blade; croziers in groups of three; sori circular; indusia absent .... *Gymnocarpium dryopteris*
1. Blades not ternate; croziers borne singly 2
    2. Blades broadly triangular, mostly as wide or wider than long; rachises winged; indusia absent .... *Phegopteris hexagonoptera*
    2. Blades longer than wide; rachises not winged 3

3. Stipes wiry, densely covered with brownish hairs, without scales; indusia only the reflexed margins of the fertile segments .... *Cheilanthes lanosa*

3. Stipes glabrous or hairy but not densely so, indusia laterally attached or cuplike or hoodlike or raylike 4

   4. Stipe bundles remain separate nearly to the blade .... species of *Cystopteris*

   4. Stipe bundles soon united upward 5

5. Pinnae with stalks, lower pair usually longer than middle pinnae; sori linear; indusia laterally attached .... KEY 11

5. Pinnae sessile, lowest pair usually shorter than middle pinnae; sori circular; indusia cuplike when young, raylike with age .... *Woodsia obtusa*

KEY 65

1. Fronds dimorphic; croziers not formed; stipe bundles forming a nearly closed ring .... KEY 47

1. Fronds not dimorphic; croziers present on young plants; stipe bundles not forming a ring 2

   2. Blades mostly 10-20 cm long, with 5-20 pairs of pinnae; stipe bundles oval or short-linear; sori circular to oblong .... KEY 34

   2. Blades mostly 40-90 cm long, with 15-40 pairs of pinnae; stipe bundles long-linear; sori long-linear and curved, usually hooked at one end . ...*Athyrium filix-femina*

KEY 66

.... species of *Botrychium*

KEY 67

1. Fronds dimorphic; sori absent on leafy blades.... species of *Botrychium* (except *B. lunaria* and *B. virginianum*)

1. Fronds not dimorphic, sori borne on leafy blades. 2

   2. Stipes about ¼ as long as blade; blades mostly with 30-40 pairs of pinnae; sori circular....... ....*Polystichum braunii*

   2. Stipes about as long as blade; blades mostly with 15-20 pairs of pinnae; sori linear, forming two rows along the midveins .... *Woodwardia virginica*

KEY 68

1. Indusia absent but often with indusium-like reflexed margins of the pinnae .... KEY 48

1. Indusia cuplike when young, raylike with age.... ....species of *Woodsia*

KEY 69

1. Sori oblong-linear, forming two rows along the midveins; veins mostly free but reticulate along the midveins .... *Woodwardia virginica*

1. Sori circular; veins all free 2

   2. Stipes smooth or scurfy above the middle, scales absent or only a few at base, with 3 bundles at extreme base, soon becoming 2 and then 1 upward; indusia absent.................... ....*Polypodium virginianum*

   2. Stipes with scales at base and often above the middle, with 3-9 bundles at base and upward; indusia peltate or reniform 3

3. Fronds dimorphic, fertile fronds with much reduced pinnae on upper part of blade; pinnae auriculate on upper side at base ....*Polystichum acrostichoides*

3. Fronds not dimorphic; pinnae not auriculate ..... species of *Dryopteris* (except *D. campyloptera*, *D. intermedia*, and *D. spinulosa*)

KEY 70

1. Blades broadly triangular, mostly as wide or wider than long; rachises winged; indusia absent ....*Phegopteris hexagonoptera*

1. Blades narrowly triangular to ovate, lanceolate, or elliptic, longer than wide 2

   2. Stipes wiry, densely covered with brownish hairs, without scales; indusia only the reflexed margins of fertile segments.................. ....*Cheilanthes lanosa*

   2. Stipes glabrous or hairy, if densely hairy then with scales also; indusia never of reflexed margins 3

3. Stipe bundles separate nearly to the blade; sori circular .... species of *Cystopteris*

3. Stipe bundles soon united upward 4

   4. Sori linear .... KEY 11

   4. Sori circular 5

5. Blades 8-20 cm wide; mature stipes without hairs or scales; indusia reniform, often circular but with a sinus .... *Thelypteris palustris*

5. Blades 1-5 cm wide, or if wider then stipes hairy and scaly; indusia cuplike when young, raylike with age .... KEY 26

KEY 71

1. Veins of leafy blades mostly reticulate, only the outer ones free .... KEY 20

1. Veins of leafy blades not reticulate 2

2. Fertile and sterile blades separate, but on a common stipe .... KEY 31

2. Fertile and sterile blades from separate stipes, or fertile and sterile pinnae on the same blade 3

3. Blades pinnate above to bipinnate below, with 5-11 pairs of pinnae; stipes with 1 linear bundle ....*Pellaea atropurpurea*

3. Blades pinnate below, mostly with 15 or more pairs of pinnae; stipes with 2-5 bundles at base 4

4. Stipes and rachises densely scaly; each pinna with an auricle on the upper side at base; stipes with 4 or 5 circular bundles at base and upward; sori circular; indusia peltate, circular without a sinus ... *Polystichum acrostichoides*

4. Stipes and rachises with few or no scales; stipes with 2 oval or linear bundles at base; sori linear; indusia laterally attached 5

5. Blades 2-7 cm wide; pinnae oblong, length less than 3 times the width; sori fewer than 15 per pinna .... *Asplenium platyneuron*

5. Blades 10-15 cm wide; pinnae linear-lanceolate, length more than 5 times the width; sori usually more than 20 per pinna .. *Athyrium pycnocarpon*

KEY 72

1. Blades ternate, each third triangular; stipe bundles free nearly to the blade....................... ....*Gymnocarpium dryopteris*

1. Blades not ternate 2

2. Blades broadly triangular, at least 2/3 as wide as long; rachises winged; indusia absent......... ....species of *Phegopteris*

2. Blades narrowly triangular or ovate or elliptic 3

3. Stipes densely covered with brownish hairs, without scales; indusia only the reflexed, unmodified, green margins of the pinnules ....*Cheilanthes lanosa*

3. Stipes glabrous or with hairs; true indusia present, at least on young sori 4

4. Stipe bundles separate nearly to the blade; rachises without scales; indusia laterally attached, hoodlike .... *Cystopteris fragilis*

4. Stipe bundles soon united upward; indusia cuplike when young, raylike with age ....species of *Woodsia*

KEY 73

1. Veins mostly reticulate ...... *Lorinseria areolata*

1. Veins mostly free 2

2. Stipes densely covered with brownish hairs, without scales; indusia only the unmodified, green margins of the pinnules ....*Cheilanthes lanosa*

2. Stipes glabrous or with a few hairs; indusia laterally attached 3

3. Length of longest pinna usually less than 5 times its width; sori fewer than 15 per pinna.......... ....species of *Asplenium*

3. Length of longest pinna usually more than 3 times its width; sori usually more than 20 per pinna ... .species of *Athyrium*

KEY 74

1. Veins of leafy pinnae mostly reticulate, with only the outer ones free .... KEY 20

1. Veins of leafy pinnae mostly free, rarely a few reticulate along the midvein 2

2. Fronds strongly dimorphic, fertile and sterile blades on a common stipe; without sori on leafy blades ....KEY 31

2. Fronds not dimorphic or only slightly so; sori present on leafy blades 3

3. Blades 10 cm or more wide; middle pinnae usually more than 7 times as long as wide; stipes with 2 linear bundles at base; sori usually more than 20 per pinna .... *Athyrium pycnocarpon*

3. Blades 7 cm or less wide; middle pinnae usually less than 7 times as long as wide; stipes with 1 or 2 oval bundles at base; sori usually fewer than 15 per pinna ....species of *Asplenium* (except *A. montanum*)

KEY 75

1. Stipes without scales (except a few at base), with 3 bundles at extreme base, these united upward to 2 and then 1; indusia absent ....*Polypodium virginianum*

1. Stipes usually with scales, with 3 or more bundles at base and upward; indusia peltate or reniform 2

2. Pinnae or pinnules auriculate on one side at base; indusia peltate, circular, without a sinus . ...species of *Polystichum*

2. Pinnae or pinnules not auriculate; indusia reniform, often circular but with a sinus .... species of *Dryopteris* (except *D. marginalis*)

KEY 76

1. Sori linear, forming two rows along the midveins; veins mostly free but reticulate along the midveins .... *Woodwardia virginica*
1. Sori circular; veins all free 2
   2. Rachises with long hairs among the scales; stipes about ¼ or less as long as blade; basal pinnae ¼ or less as long as middle pinnae; indusia peltate, circular without a sinus .... *Polystichum braunii*
   2. Rachises glabrous or with short hairs; indusia reniform, sometimes appearing to be circular, but the sinus is usually evident.................................... species of *Dryopteris*

KEY 77

1. Blades broadly triangular, 2/3 (or more) as wide as long; indusia absent ...... species of *Phegopteris*
1. Blades narrowly triangular to ovate, lanceolate, or elliptic 2
   2. Pinnae attached to rachis as broadly as their width; sori mostly 1 mm or more in diameter; indusia absent .... *Polypodium virginianum*
   2. Pinnae narrowly attached to rachis; sori 1 mm or less in diameter; indusia present, at least when young 3
3. Sori linear .... *Asplenium montanum*
3. Sori circular 4
   4. Stipe bundles free nearly to the blade; rachises without scales; indusia hoodlike....................................... species of *Cystopteris*
   4. Stipe bundles soon united to 1 upward 5
5. Blades 8-20 cm wide; mature stipes without hairs or scales; indusia reniform, often circular but with a sinus .... *Thelypteris palustris*
5. Blades 1-5 cm wide, or if wider, then stipes hairy and scaly; indusia cuplike when young, raylike with age .... species of *Woodsia*

KEY 78

1. Fronds dimorphic or not, with sori on leafy blades; stipes slender, wiry, purplish or reddish.................................. *Pellaea atropurpurea*
1. Fronds strongly dimorphic, without sori on leafy blades; stipes mostly 2-5 mm in diameter 2
   2. Fertile and sterile blades separate but on a common stipe; stipe bundle not curled in at the ends; croziers not formed .... species of *Botrychium*
   2. Fertile and sterile blades on separate stipes or fertile and sterile pinnae on separate parts of the same blade; stipe bundle strongly curled in at the ends; croziers present on young plants .... species of *Osmunda*

KEY 79

1. Stipes densely covered with brownish hairs, without scales; indusia only the reflexed, unmodified, green margins of the pinnules .... *Cheilanthes lanosa*
1. Stipes glabrous or with hairs; indusia present or absent but not as reflexed margins 2
   2. Blades pinnatifid to pinnate .... *Polypodium virginianum*
   2. Blades pinnate-pinnatifid to tripinnate 3
3. Blades broadly triangular, 2/3 (or more) as wide as long; indusia absent ...... species of *Phegopteris*
3. Blades narrowly triangular to ovate, lanceolate, or elliptic 4
   4. Stipe bundles free nearly to the blade; rachises without scales; indusia hoodlike....................................... species of *Cystopteris*
   4. Stipe bundles soon united to 1 upward 5
5. Blades 8-20 cm wide; mature stipes without hairs or scales; indusia reniform, often circular but with a sinus .... *Thelypteris palustris*
5. Blades 1-5 cm wide, or if wider then stipes hairy and scaly; indusia cuplike when young, raylike with age .... species of *Woodsia*

KEY 80

1. Blades ternate, each third triangular; stipe bundles free nearly to the blade.. *Gymnocarpium dryopteris*
1. Blades not ternate .... KEY 79

KEY 81

1. Fertile and sterile blades separate, but on a common stipe 2
1. Fertile and sterile blades on separate stipes, or blades partly fertile and partly sterile 4
   2. Common stipes 0.5-6 cm long, much shorter than stalk of fertile blade; stalks of sterile blades more than 2 cm long .. *Botrychium dissectum*
   2. Common stipes 6-20 cm long, much longer than stalk of fertile blade; stalks of sterile blades less than 2 cm long 3

3. Stalks of sterile blades 0-0.6 cm long; stalks of fertile blades 0.5-1.5 cm long; sterile blades pinnate-pinnatifid or bipinnate .. *Botrychium lanceolatum*

3. Stalks of sterile blades 0.2-1.5 cm long; stalks of fertile blades 1-4 cm long; sterile blades pinnate or pinnate-pinnatifid ... *Botrychium matricariifolium*

4. Veins of sterile blades reticulate; fertile blades with spherical sori that resemble strings of beads .... *Onoclea sensibilis*

4. Veins of sterile blades not reticulate; sori not beadlike 5

5. Sterile blades with 5-11 pairs of pinnae.......... .... KEY 16

5. Sterile blades with 15 or more pairs of pinnae 6

6. Fertile and sterile pinnae much different, without sori on leafy pinnae 7

6. Fertile and sterile pinnae slightly different, sori borne on leafy pinnae 8

7. Fertile and sterile pinnae on separate fronds; stipes with scales, with 2 bundles at base; lowest pinnae very short, ¼ (or less) as long as middle pinnae.. ....*Matteuccia struthiopteris*

7. Fertile and sterile pinnae on separate fronds or on separate parts of the same frond; stipes without scales, hairs may be present, with 1 bundle at base; lowest pinnae about ¾ (or more) as long as middle pinnae .... KEY 22

8. Stipes densely scaly; each pinna with an auricle, margins with bristle-tipped teeth; stipes with 4 or 5 bundles at base ....*Polystichum acrostichoides*

8. Stipes with a few scales when young; pinnae without auricles; margins entire or shallowly toothed; stipes with 2 bundles at base 9

9. Stipes with 2 circular or oval bundles at base; lowest pair of pinnae equal to or slightly shorter than middle pinnae; veins forked, at least on sterile segments; sori circular .... *Thelypteris palustris*

9. Stipes with 2 linear, curved bundles at base; lowest pair of pinnae ¾ or less the length of middle pinnae and usually pointing downward; veins rarely forked; sori linear ...... *Athyrium thelypterioides*

KEY 82

1. Fertile and sterile blades separate but on a common stipe .... species of *Botrychium* (except *B. lunaria* and *B. virginianum*)

1. Fertile and sterile blades on separate stipes or fertile and sterile pinnae on separate parts of the same blade 2

2. Fertile pinnae not leafy, much unlike sterile pinnae; stipe with 1 large, horseshoe-shaped bundle that is strongly curled in at the ends ....species of *Osmunda*

2. Fertile pinnae leafy; stipe bundles 1 or 2, not curled in at the ends 3

3. Sterile blades with 12 or more pairs of pinnae; stipe with 2 bundles at base; sori circular and not marginal; indusia reniform, often circular but with a sinus .... *Thelypteris palustris*

3. Sterile blades with 5-11 pairs of pinnae; stipe with 1 bundle; indusia absent .... KEY 16

KEY 83

1. Fronds strongly dimorphic, without sori on leafy pinnules 2

1. Fronds not or slightly dimorphic, with sori on leafy pinnules .... KEY 36

2. Fertile and sterile blades separate, but on a common stipe; stipe bundle not curled in at the ends; croziers not formed .... species of *Botrychium* (except *B. lunaria* and *B. virginianum*)

2. Fertile and sterile blades on separate stipes or fertile and sterile pinnae on separate parts of the same blade; stipe bundle curled in at the ends; croziers present on young plants ....species of *Osmunda*

KEY 84

1. Fronds dimorphic, fertile and sterile blades separate, but on a common stipe; sori absent on leafy blades ....KEY 47

1. Fronds not dimorphic; sori borne on leafy blades 2

2. Blades ternate, each third triangular; stipe bundles free nearly to the blade ....*Gymnocarpium dryopteris*

2. Blades not ternate 3

3. Blades broadly triangular, mostly as wide or wider than long; rachises winged; indusia absent ....*Phegopteris hexagonoptera*

3. Blades narrowly triangular to ovate, lanceolate, or elliptic, usually longer than wide; indusia present, at least on young sori 4

4. Stipes densely covered with brownish hairs, without scales; indusia only the reflexed, unmodified, green margin of the pinnule .... *Cheilanthes lanosa*

4. Stipes glabrous or with a few hairs; true indusia present, at least on young sori 5

5. Sori circular 6

5. Sori linear 7

6. Stipe bundles free nearly to the blade; rachises without scales; veins of the pinnules extend to the margin; young indusia hoodlike, attached at one side ....species of *Cystopteris*

6. Stipe bundles soon united to 1 upward; veins do not reach the margin; young indusia cuplike, soon splitting into rays ...... *Woodsia obtusa*

7. Stipes without scales above the middle; mature blades 3-15 cm long, 2-7 cm wide, with 2-12 pairs of pinnae .... KEY 11

7. Stipes with scales; mature blades 30-60 cm long, 10-35 cm wide, with 15-40 pairs of pinnae.............. *Athyrium filix-femina*

KEY 85

1. Blades ternate, each third triangular; stipe bundles free nearly to the blade............ *Gymnocarpium dryopteris*

1. Blades not ternate 2

2. Blades broadly triangular, at least 2/3 as wide as long; rachises winged; indusia absent.........species of *Phegopteris*

2. Blades narrowly triangular or ovate or elliptic 3

3. Stipes densely covered with brownish hairs, without scales; indusia only the reflexed, unmodified, green margin of the pinnules .... *Cheilanthes lanosa*

3. Stipes glabrous or with hairs; true indusia present, at least on young sori 4

4. Indusia reniform, often circular but with a sinus, usually with tiny hairs or glands on the margin; blades 8-20 cm wide ....species of *Thelypteris*

4. Indusia not reniform 5

5. Stipe bundles separate nearly to the blade; rachises without scales; veins of pinnae extend to the margin; young indusia hoodlike, attached at one side .... species of *Cystopteris*

5. Stipe bundles unite to 1 upward; veins do not reach the margin; young indusia cuplike, soon splitting into rays ....species of *Woodsia*

KEY 86

1. Veins of leafy blades mostly reticulate, only the outer ones free .... KEY 20

1. Veins of leafy blades not reticulate 2

2. Fertile and sterile blades separate but from a common stipe .... species of *Botrychium*

2. Fertile and sterile blades on separate stipes or fertile and sterile pinnae on separate parts of the same blade 3

3. Fertile and sterile blades much different, without sori on leafy blades; fertile blades feather-like.... *Matteuccia struthiopteris*

3. Fertile and sterile blades slightly different, sori borne on leafy blades 4

4. Sori circular; indusia reniform, circular but with a sinus .... *Thelypteris palustris*

4. Sori linear; indusia laterally attached 5

5. Stipe bundles oval or short-linear; blades 2-7 cm wide; pinnae oblong, length less than 3 times the width; sori fewer than 15 per pinna............. *Asplenium platyneuron*

5. Stipe bundles long-linear; blades mostly 10-25 cm wide; pinnae linear-lanceolate, length more than 5 times the width; sori usually more than 20 per pinna 6

6. Blades pinnate, usually with 20-30 pairs of pinnae; rachises without scales .... *Athyrium pycnocarpon*

6. Blades pinnate-pinnatifid, usually with 15-20 pairs of pinnae; rachises with a few scales .... *Athryium thelypterioides*

KEY 87

1. First division of blade ternate, each of the three divisions triangular; stipes with 2 bundles at base and upward .... *Gymnocarpium dryopteris*

1. Blades not ternate 2

2. Stipes densely scaly, with 3-9 bundles at base and upward; indusia reniform, often circular but with a sinus .... *Dryopteris marginalis*

2. Stipes with 1 or 2 bundles at base; indusia not reniform 3

3. Blades broadly triangular, at least 2/3 as wide as long; rachises winged ..... species of *Phegopteris*

3. Blades narrowly triangular to ovate, lanceolate, or elliptic 4

4. Stipes shorter than blade, without scales, with 1 large horseshoe-shaped bundle; pinnules with white, glandular hairs; indusia cuplike .... *Dennstaedtia punctilobula*

4. Stipes with 1 or 2 circular, oval, or short-linear bundles 5

5. Indusia of only the reflexed margins of the pinnules; stipes with 1 bundle (rarely 2) 6

5. Indusia present, at least on young sori; stipes with 2 bundles at base 7

6. Stipes and rachises densely covered with brownish hairs, without scales .... *Cheilanthes lanosa*

6. Stipes and rachises glabrous or with short, rough hairs .... KEY 35

7. Stipes with 2 bundles at base which remain separate nearly to the blade; rachises without scales; veins of pinnae extend to the margin; indusia hoodlike, attached at one side .... *Cystopteris fragilis*

7. Stipes with 2 bundles at base that soon unite upward; rachises with or without scales; veins do not reach the margin; young indusia cuplike when young, raylike with age ..... species of *Woodsia*

KEY 88

1. Stipes with 1 or 2 bundles at base 2

1. Stipes with 3-9 bundles at base and upward ... 3

2. Blades broadly triangular, mostly as wide or wider than long; rachises winged; indusia absent ....*Phegopteris hexagonoptera*

2. Blades narrowly triangular to ovate, lanceolate, or elliptic; indusia present, at least on young sori 4

3. Base of pinnule auriculate on the side facing upward; indusia peltate, circular without a sinus ....*Polystichum braunii*

3. Base of pinnule not auriculate; indusia reniform, often circular but with a sinus ....species of *Dryopteris* (except *D. marginalis*)

4. Stipe bundles free nearly to the blade or into the rachis; rachises without scales; veins of pinnules extend to the margin; indusia laterally attached, hoodlike .... species of *Cystopteris*

4. Stipe bundles soon united to 1 upward; indusia reniform, cuplike, or raylike 5

5. Mature stipes and rachises with hairs and scales; indusia cuplike when young, raylike with age ....*Woodsia obtusa*

5. Mature stipes mostly without hairs or scales above the middle; rachises without scales; indusia reniform, often circular but with a sinus ....species of *Thelypteris*

KEY 89

1. Blades broadly triangular, 2/3 (or more) as wide as long; indusia absent ...... species of *Phegopteris*

1. Blades narrowly triangular to ovate, lanceolate, or elliptic 2

2. Pinnae attached to rachis for their entire widths; sori (0.5-)1-2 mm in diameter; indusia absent .... *Polypodium virginianum*

2. Pinnae variously attached to rachis; sori 0.4-1 mm in diameter; indusia present, at least when young 3

3. Stipes with 1 or 2 bundles at base 4

3. Stipes with 3-9 bundles at base and upward ... 6

4. Stipe bundles free nearly to blade; blades 4-15 cm wide; rachises without scales; indusia hoodlike .... species of *Cystopteris*

4. Stipe bundles soon united to 1 upward 5

5. Mature blades 1-5 cm wide; indusia cuplike when young, raylike with age ..... species of *Woodsia*

5. Mature blades 8-20 cm wide; indusia reniform, often circular but with a sinus ....species of *Thelypteris*

6. Mature blades less than 6 cm wide; stipe about ¼ as long as blade; basal pinnae ¼-½ as long as middle pinnae .... *Dryopteris fragrans*

6. Mature blades more than 6 cm wide 7

7. Blades 20-50 cm wide; stipe ¾ to as long as blade; basal pinnae usually shaped like those above, and about same length as middle pinnae ....*Dryopteris goldiana*

7. Blades 6-20 cm wide; stipes ¼ to as long as blade; basal pinnae usually shorter than those above and broader at base, being somewhat triangular ... 8

8. Fertile fronds usually taller and more erect than sterile fronds; blades 6-18 cm wide; basal pinnae usually broadly triangular and shorter than middle pinnae .... *Dryopteris cristata*

8. Fertile and sterile fronds alike; blades 10-30 cm wide; basal pinnae usually narrowly triangular and slightly shorter or equal to middle pinnae ....*Dryopteris clintoniana*

KEY 90

1. Fronds strongly dimorphic with fertile and sterile blades on a common stipe; without sori on leafy blades .... species of *Botrychium* (except *B. lunaria* and *B. virginianum*)

1. Fronds not dimorphic or only slightly so; sori borne on leafy blades 2

    2. Blades broadly triangular, mostly as wide or wider than long, rachises winged; indusia absent ....*Phegopteris hexagonoptera*

    2. Blades narrowly triangular to ovate, lanceolate, or elliptic; indusia present, at least on young sori 3

3. Stipe bundles remain separate nearly to the blade or into the rachis; rachises without scales; veins of pinnules extend to the margin; sori circular ....species of *Cystopteris*

3. Stipe bundles soon united to 1 upward 4

    4. Blades 1-6 cm wide 5

    4. Blades 6-20 cm wide 6

5. Pinnae 7-23 pairs, sessile on the rachis; sori circular .... KEY 26

5. Pinnae 2-12 pairs, with stalks; sori linear ....KEY 11

    6. Stipe bundles at base usually about three times as long as wide; sori linear, curved ....*Athyrium filix-femina*

    6. Stipe bundles at base usually not more than twice as long as wide; sori circular 7

7. Blades pinnate-pinnatifid to nearly bipinnate; stipes glabrous or with a few hairs, without scales above the middle; rachises without scales; indusia reniform, often circular but with a sinus ....species of *Thelypteris*

7. Blades pinnate-bipinnatifid to bipinnate-pinnatifid; stipes and rachises with hairs and scales; indusia cuplike when young, raylike with age ....*Woodsia obtusa*

KEY 91

1. Veins of leafy blades mostly reticulate, only the outer ones free .... *Onoclea sensibilis*

1. Veins of leafy blades mostly not reticulate ... 2

    2. Fronds strongly dimorphic, sterile and fertile blades much different 3

    2. Fronds not dimorphic or only slightly so ..6

3. Sterile and fertile blades on separate stipes; leafy blades more than 40 cm long..........*Matteuccia struthiopteris*

3. Sterile and fertile blades on a common stipe; leafy blades less than 10 cm long 4

    4. Common stipe much shorter than stalk of fertile blade; stalk of sterile blade more than 2 cm long .... *Botrychium dissectum*

    4. Common stipe much longer than stalk of fertile blade; stalk of sterile blade less than 2 cm long 5

5. Stalk of sterile blade 0-0.6 cm long; stalk of fertile blade 0.5-1.3 cm long; sterile blade pinnate-pinnatifid or bipinnate ....*Botrychium lanceolatum*

5. Stalk of sterile blade 0.2-1.5 cm long; stalk of fertile blade 1-4 cm long; sterile blade pinnate or pinnate-pinnatifid .... *Botrychium matricariifolium*

    6. Blades broadly triangular, ⅔ (or more) as wide as long; rachises winged; sori circular; indusia absent ...... species of *Phegopteris*

    6. Blades narrowly triangular to ovate, lanceolate, or elliptic; indusia present on fertile blades 7

7. Stipe bundles separate nearly to the blade or into the rachis; rachises without scales; sori circular; indusia hoodlike, attached at one side ....species of *Cystopteris*

7. Stipe bundles united to 1 below the middle of the stipe 8

    8. Mature blades up to 7 cm wide 9

    8. Mature blades more than 7 cm wide ... 10

9. Pinnae sessile or nearly so; sori circular ....species of *Woodsia*

9. Pinnae stalked; sori linear. .*Asplenium montanum*

    10. Lowest pair of pinnae much shorter than middle pinnae 11

    10. Lowest pair of pinnae nearly as long as middle pinnae 12

11. Stipe about ½ to ¾ as long as blade; rachis with hairs and a few scales; sori linear ....*Athyrium thelypterioides*

11. Stipe about ¼ as long as blade; rachis glabrous or with a few hairs, without scales; sori circular ....*Thelypteris noveboracensis*

    12. Veins of sterile pinnae mostly forked; young fertile fronds with partially inrolled margins; indusia ciliate .... *Thelypteris palustris*

    12. Veins of sterile pinnae not forked; fertile fronds with flat margins; indusia with tiny glands .... *Thelypteris simulata*

KEYS TO SPECIES WHEN GENUS IS KNOWN

ADIANTUM

One species in our area .... *A. pedatum*

ASPLENIUM

1. Blades pinnate 2

1. Blades pinnate-pinnatifid to bipinnate-pinnatifid, at least lower part of blade; rachis green..........4

   2. Basal pinnae shorter than middle pinnae, usually less than ½ as long; basal lobes overlapping the rachis .... *A. platyneuron*

   2. Basal pinnae about same length or longer than middle pinnae, rarely only ¾ as long; basal lobes not overlapping the rachis 3

3. Rachises and stipes dark brown, without hairs or scales .... *A. trichomanes*

3. Rachises and upper part of stipe light green, with hairlike scales .... *A. viride*

   4. Stipes green throughout, slender; blades with 2-6 pairs of pinnae; veins of pinnules fanlike.. ....*A. ruta-muraria*

   4. Stipes brown at base, green above; blades with 5-12 pairs of pinnae; veins obscure........... ....*A. montanum*

ATHYRIUM

1. Blades bipinnate to tripinnate; sori curved, often hooked at one end .... *A. filix-femina*

1. Blades pinnate or pinnate-pinnatifid; sori straight or nearly so 2

   2. Blades pinnate; rachises without scales ....*A. pycnocarpon*

   2. Blades pinnate-pinnatifid; young rachises with narrow scales .... *A. thelypterioides*

AZOLLA

One species in our area .... *A. caroliniana*

BOTRYCHIUM

1. Stalks of sterile blades 0-1.5 cm long 2

1. Stalks of sterile blades 2.5-15 cm long 7

   2. Sterile blades sessile, bipinnate-pinnatifid to nearly tripinnate .... *B. virginianum*

   2. Sterile blades pinnatifid to bipinnate 3

3. Sterile blades attached below the middle of the frond; lowest pinnae about as wide as long 4

3. Sterile blades attached above the middle of the frond 5

   4. Sterile blades sessile or with stalks less than 1/5 as long as blades, with 3-10 pairs of pinnae that are at a right-angle to the rachis .... *B. lunaria*

   4. Sterile blades with stalks ⅓ to ½ as long as blades, with 1-5 pairs of pinnae that usually are oblique to the rachis .... *B. simplex*

5. Sterile blades sessile or nearly so............... ....*B. lanceolatum*

5. Sterile blades with stalks 6

   6. Pinnae of sterile blades lobed or pinnatifid; basal pinnae longer than wide.................. ....*B. matricariifolium*

   6. Pinnae of sterile blades obovate, not or scarcely lobed; basal pinnae about as wide as long ....*B. simplex*

7. Pinnule lobes or segments of sterile blades obtuse, about as long as wide .... *B. oneidense*

7. Pinnule lobes or segments of sterile blades acute or obtuse, 2-5 times as long as wide 8

   8. Sterile blades thin, membranous or slightly leathery, often lacelike in appearance; pinnule segments variable in size and shape but usually more than twice (often 4 or 5 times) as long as wide with ultimate lobes or teeth somewhat parallel-sided and mostly acute at apex ....*B. dissectum*

   8. Sterile blades thick, leathery or fleshy; pinnule segments of similar size and shape and mostly not more than twice (rarely 3 times) as long as wide with ultimate lobes or teeth not parallel-sided and mostly obtuse at apex............. ....*B. multifidum*

CAMPTOSORUS

One species in our area .... *C. rhizophyllus*

CHEILANTHES

One species in our area .... *C. lanosa*

CRYPTOGRAMMA

One species in our area .... *C. stelleri*

CYSTOPTERIS

1. Blades narrowly triangular to linear-lanceolate, long-tapering to apex; pinnae 20-40 pairs; basal pinnae slightly longer than next pair above; veins mostly running to the sinuses between marginal teeth; rachises often with bulblets .. *C. bulbifera*
1. Blades variable, but usually ovate to ovate-lanceolate, not long-tapering to apex; pinnae 9-15 pairs; basal pinnae slightly shorter than next pair above; veins mostly running to the marginal teeth; rachises never with bulblets .... *C. fragilis*

DENNSTAEDTIA

One species in our area .... *D. punctilobula*

DRYOPTERIS

(Apparently any of our species of *Dryopteris* may hybridize with other species of the genus, forming sterile or fertile hybrids. This key separates only those recognized as distinct species. The user should be aware that intermediates occur.)

1. Mature blades less than 6 cm wide; stipe about ¼ as long as blade; basal pinnae ¼-½ as long as middle pinnae .... *D. fragrans*
1. Mature blades more than 6 cm wide 2
   2. Sori marginal or nearly so; pinnule margins with obscure teeth with no bristle at tip .... *D. marginalis*
   2. Sori not marginal; pinnule margins having teeth with a bristle at tip 3
3. Blades pinnate-pinnatifid to nearly bipinnate-pinnatifid; basal pinnae nearly equal-sided; teeth tipped with very short bristle 4
3. Blades bipinnate-pinnatifid to tripinnate-pinnatifid; basal pinnae strongly unequal-sided; teeth ending in long bristle 6
   4. Blades 20-50 cm wide; stipe ¾ to as long as blade; basal pinnae usually shaped like those above and about same length as middle pinnae .... *D. goldiana*
   4. Blades 6-30 cm wide; stipe ¼ to as long as blade; basal pinnae usually shorter than those above and broader at base, being somewhat triangular 5
5. Fertile fronds usually taller and more erect than sterile fronds; blades 6-18 cm wide; basal pinnae usually broadly triangular and shorter than middle pinnae .... *D. cristata*
5. Fertile and sterile fronds alike; blades 10-30 cm wide; basal pinnae usually narrowly triangular and slightly shorter or equal to middle pinnae .... *D. clintoniana*
   6. Lowest basal pinnule on lower side of lowest pinna shorter than pinnule closest to it; hairs present on stipe, rachis, and indusia .... *D. intermedia*
   6. Lowest basal pinnule on lower side of lowest pinna longer than pinnule closest to it; fronds without hairs 7
7. Basal pair of pinnules of lowest pinna opposite or nearly so (4 mm or less apart); the pinnule closest to the rachis on the lower side of the lowest pinna about twice as long and slightly wider at base than the opposing pinnule .... *D. spinulosa*
7. Basal pair of pinnules of lowest pinna alternate (4 mm or more apart); the pinnule closest to the rachis on the lower side of the lowest pinna two or three times as long and much wider than the opposing pinnule .... *D. campyloptera*

GYMNOCARPIUM

One species in our area .... *G. dryopteris*

LORINSERIA

One species in our area .... *L. areolata*

LYGODIUM

One species in our area .... *L. palmatum*

MARSILEA

One species in our area .... *M. quadrifolia*

MATTEUCCIA

One species in our area .... *M. struthiopteris*

ONOCLEA

One species in our area .... *O. sensibilis*

OPHIOGLOSSUM

One species in our area .... *O. vulgatum*

OSMUNDA

1. Blades bipinnate; pinnule margins serrulate; pinnae stalked; fertile pinnae above sterile pinnae on same blade .... *O. regalis*
1. Blades pinnate-pinnatifid; pinnule margins entire; pinnae sessile; fertile pinnae between sterile pinnae on same blade or on separate blades 2
   2. Fertile and sterile pinnae on separate blades; sterile pinnae (when young) with a tuft of hairs at base .... *O. cinnamomea*
   2. Fertile and sterile pinnae on the same blade; sterile pinnae without tuft of hairs .... *O. claytoniana*

PELLAEA

1. Fronds usually dimorphic; stipes and rachises with rough appressed hairs; blades grayish green; stalks of lowest pair of pinnae 1-10 mm long .... *P. atropurpurea*
1. Fronds not strongly dimorphic; stipes and rachises glabrous or with a few spreading hairs; blades bluish green; stalks of lowest pair of pinnae 0-3 mm long .... *P. glabella*

PHEGOPTERIS

1. Lowest pair of pinnae longer than the pair next above, and joined to it at the winged rachis; blades mostly as wide or wider than long; rachises with a few scales .... *P. hexagonoptera*
1. Lowest pair of pinnae shorter than the pair next above and not joined to it; blades not as wide as long; rachises with many scales ... *P. connectilis*

PHYLLITIS

One species in our area .... *P. scolopendrium*

POLYPODIUM

One species in our area .... *P. virginianum*

POLYSTICHUM

1. Blades mostly pinnate; lowest pinnae nearly as long as middle pinnae .... *P. acrostichoides*
1. Blades mostly bipinnate; lowest pinnae much shorter than middle pinnae .... *P. braunii*

PTERIDIUM

One species in our area .... *P. aquilinum*

SCHIZAEA

One species in our area .... *S. pusilla*

THELYPTERIS

1. Blades much narrowed at base; lowest pinnae much shorter than middle pinnae............... .... *T. noveboracensis*
1. Blades scarcely narrowed at base; lowest pinnae about as long as middle pinnae 2
    2. Veins of sterile pinnae mostly forked; young fertile fronds with inrolled margins; indusia ciliate .... *T. palustris*
    2. Veins of sterile pinnae not forked; fertile fronds with flat margins; indusia with tiny glands .... *T. simulata*

WOODSIA

1. Blades 7 cm wide or more .... *W. obtusa*
1. Blades less than 7 cm wide 2
    2. Blades 3-7 cm wide 3
    2. Blades less than 3 cm wide 4
3. Stipes and rachises with many hairs and scales; stipe with a joint at or below the middle (old stipe bases rather uniform in length); indusia with many hairlike rays ....*W. ilvensis*
3. Stipes and rachises with a few hairs and scales; stipes not jointed (old stipe bases uneven in length); indusia with 3-6 short, scalelike rays..... .... *W. obtusa*
    4. Stipes and rachises without hairs or scales ... . *W. glabella*
    4. Stipes and rachises with hairs and scales ... 5
5. Blades with a few hairs; midveins of pinnae with no or few scales; pinnae mostly with 2 or 3 pairs of pinnules or pinna segments .... *W. alpina*
5. Blades with many hairs; midveins of pinnae scaly; pinnae mostly with 4 or more pairs of pinnules or pinna segments .... *W. ilvensis*

WOODWARDIA

One species in our area .... *W. virginica*

DESCRIPTIONS OF SPECIES

Adiantum pedatum Linnaeus Plate 1

MAIDENHAIR FERN

NY, Vt, NH, Me, Mass, Ct, RI, NJ, Pa.

Rich, moist, deciduous woods. Soil variable but plants appear to be more luxuriant at low acidity.

RHIZOMES woody, branched, 1-5 mm in diameter, scaly. CROZIERS clustered, reddish. FRONDS not dimorphic, coming separately but near together from points on the rhizome, mostly 20-60 cm long, not evergreen. STIPE wiry, usually a little longer than the blade, 1-3 mm wide, shiny black or brown, glabrous, often with a few scales at base, with 1 horseshoe-shaped bundle. BLADES circular or semicircular, fanlike, 12-20(-25) cm long, 20-30(-40) cm wide; rachis forked forming two nearly equal parts of the blade, each part bipinnate. PINNAE alternate, usually 10-14 (not paired), oblong, 4-17 cm long, about 4 cm wide. PINNULES 12-20 on a pinna, alternate, oblong, 1-2 cm long, 0.6-1 cm wide, glabrous; margins entire but wavy or lobed on one side. VEINS palmate, many per pinnule, forked two or three times. SORI marginal, linear. INDUSIA oblong, 2-5 mm long, being the reflexed margin of the pinnule. SPORES tetrahedral.

Adiantum capillus-veneris, SOUTHERN MAIDENHAIR FERN, ranging as far north as Virginia and Kentucky, is sometimes reported for our area but it probably does not persist.

Asplenium montanum Willdenow Plate 2

MOUNTAIN SPLEENWORT

A. bradleyi in part (which is probably a hybrid of *A. m.* and *A. platyneuron*).

NY (rare), Vt (rare), Mass (rare), Ct (rare), RI (rare), NJ, Pa.

Moist, protected, shady crevices in sandstone and other non-calcareous rocks. Soil acid, pH mostly 4-6.

RHIZOMES short, creeping, about 1 mm in diameter, scaly. FRONDS not dimorphic, clustered, 5-20 cm long, evergreen. STIPE shorter than, or about same length as blade, 2-10 cm long, brown at base, green above, not scaly, with 2 oval bundles at extreme base, united just above to form 1 nearly circular bundle. BLADES deltoid-ovate to ovate-lanceolate, 5-10 (-15) cm long, 3-6 (-7) cm wide, pinnate-pinnatifid to bipinnate-pinnatifid; rachis green, flattened. PINNAE alternate or subopposite, 5-12 pairs, ovate-oblong, stalked, lowest pair longest. PINNULES of various shapes and dissections; margins serrate. VEINS obscure, free, forked or not, not reaching the margin. SORI few, linear, separate or some confluent, not marginal. INDUSIA fragile, laterally attached. SPORES bilateral.

Resembles a blend of *Asplenium ruta-muraria* and *Cystopteris fragilis*.

Asplenium pinnatifidum Nuttall, LOBED SPLEENWORT, a southern species found as far north as New Jersey and Pennsylvania, resembles a blend of *A. montanum* and *Camptosorus rhizophyllus* and may have originated as a hybrid of these two species. It has also been called *Camptosorus pinnatifidus* and × *Asplenosorus pinnatifidus*.

Asplenium platyneuron (Linnaeus) Oakes Plate 3

EBONY SPLEENWORT

A. bradleyi, in part (which is probably a hybrid of *A. p.* and *A. montanum*).

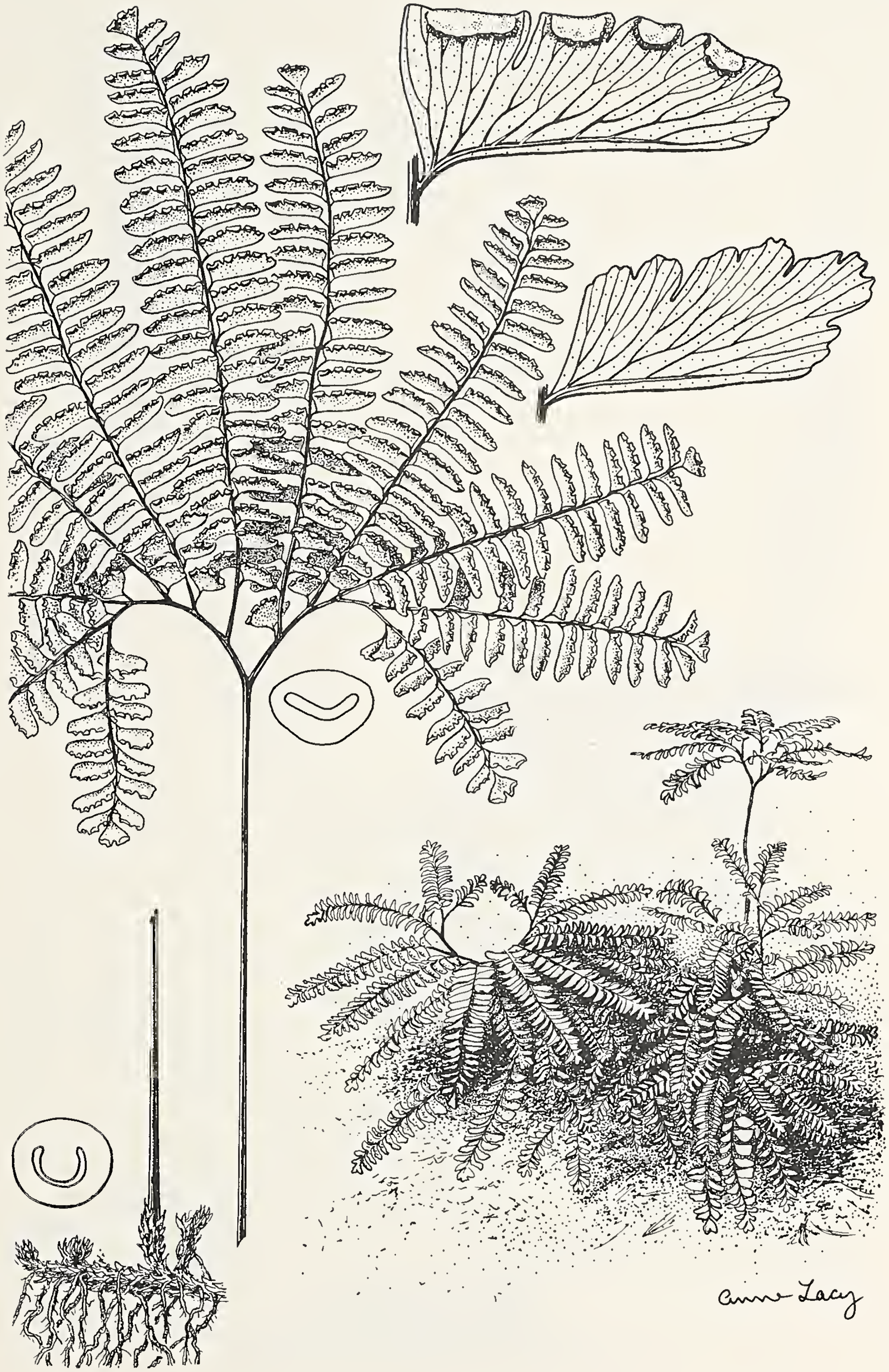
NY, Vt, NH, Me, Mass, Ct, RI, NJ, Pa.

Crevices in cliffs and shady rocky slopes, sometimes on hummocks in swamps or on sand. Soil variable as to pH; does best in acid soil but often found on cement.

RHIZOMES short, creeping or ascending, 2.5-3.5 mm in diameter, with a few scales. FRONDS dimorphic in that fertile fronds are longer than sterile fronds, clustered, (5-)15-50(-60) cm long, evergreen. STIPE much shorter than blade, dark brown, shiny, often with a few hairs or scales, with 1 or 2 circular or oval bundles at base, sometimes V-shaped or X-shaped upward. BLADES linear-lanceolate to narrowly elliptic-lanceolate, mostly 10-35 cm long, 2-7 cm wide, pinnate; rachis dark brown, shiny, with scales. PINNAE alternate, 15-25 pairs on sterile blades, 30-50 pairs on fertile blades, mostly oblong, auriculate, the auricles overlapping the rachis, sessile, lowest pair much shorter than middle ones; margins usually serrate or crenate. VEINS free, mostly once-forked, not reaching the margin. SORI short-linear, straight, 8-12 per pinna, often confluent in age, not marginal. INDUSIA fragile, silvery when young, withering in age, laterally attached. SPORES bilateral.

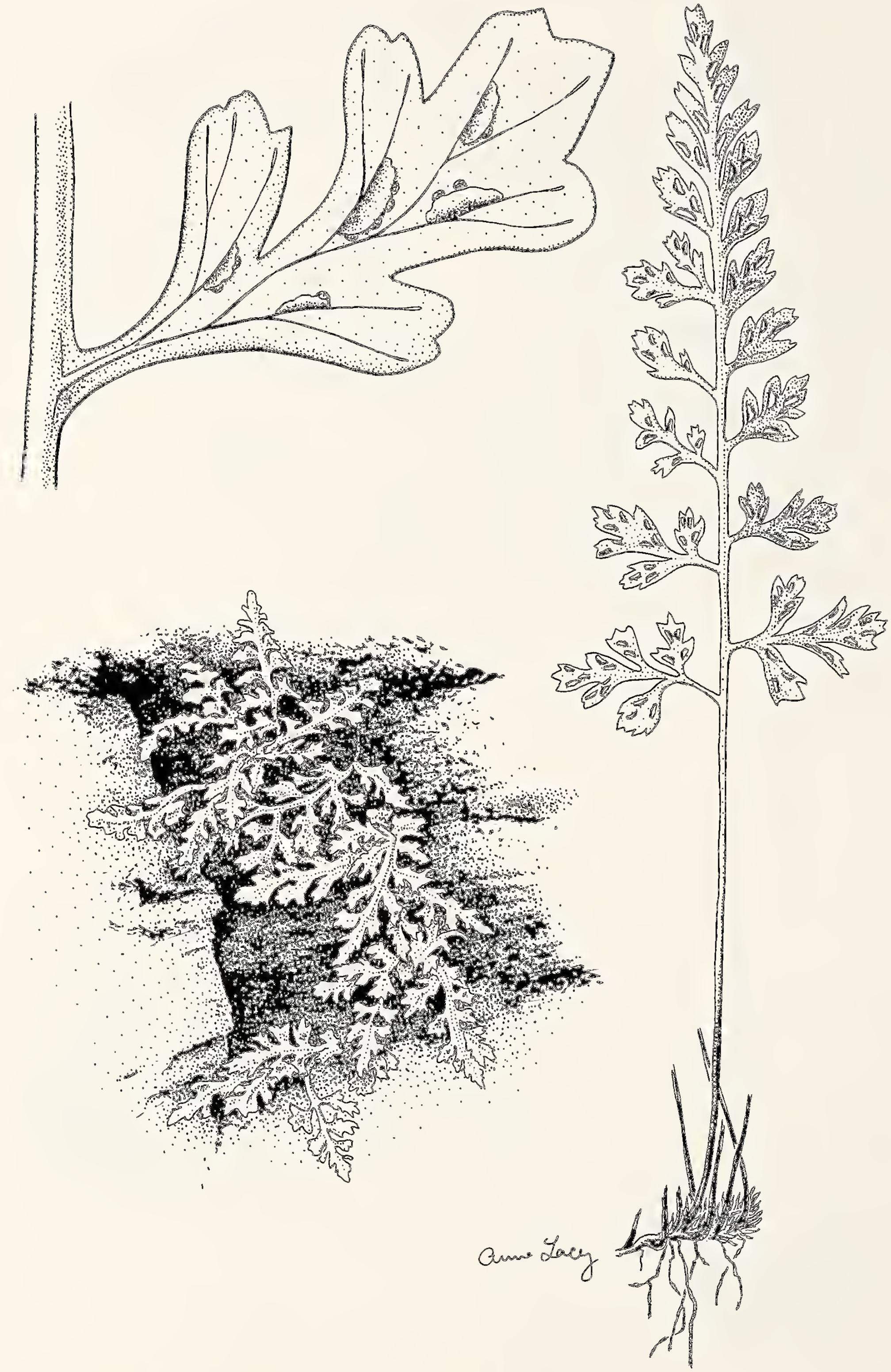
Asplenium resiliens Kunze, BLACKSTEM SPLEENWORT, has been found in Pennsylvania where it may now be extinct. Similar to *A. platyneuron* it differs in having the pinnae mostly opposite with a cuneate base, sterile fronds about the same length as the fertile fronds, with a nearly black rachis.

Plate 1



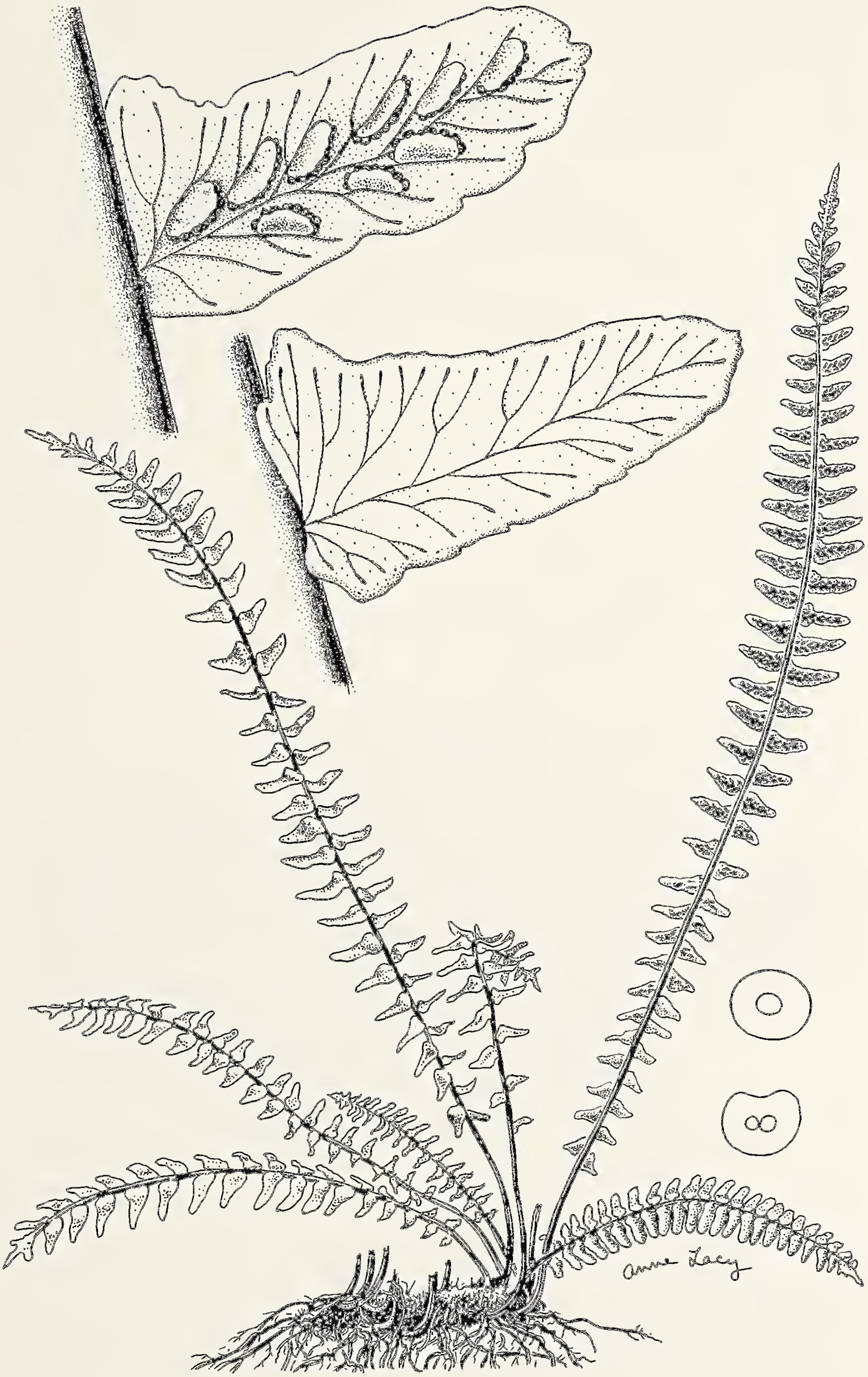
Adiantum pedatum MAIDENHAIR FERN

Plate 2



Asplenium montanum MOUNTAIN SPLEENWORT

Plate 3



Asplenium platyneuron EBONY SPLEENWORT

A. platyneuron × *A. trichomanes* and *A. platyneuron* × *Camptosorus rhizophyllus* may be looked for, especially where their parents are found together. They combine the characters of the parent species.

Asplenium ruta-muraria Linnaeus Plate 4

WALL RUE, WALL RUE SPLEENWORT

A. cryptolepis

NY, Vt, Mass, Ct, NJ, Pa.

Limestone rocks and cliffs, calcareous shale, sometimes on cement. Soil neutral to alkaline, pH 7-9.

RHIZOMES short, creeping, 1-1.5 mm in diameter, scales hidden in the roots, with persistent old stipe bases. FRONDS not dimorphic, clustered, 4-17 cm long, evergreen. STIPE longer or shorter than blade, 1.5-7 cm long, green throughout, with a few scales at base, with 2 circular or oval bundles at base, soon united above to form 1 bundle. BLADES ovate or triangular-ovate, (1-)3-6(-12) cm long, 2-4 cm wide, bipinnate to bipinnate-pinnatifid (at least the lower part); rachis green, flattened. PINNAE alternate, 2-6 pairs, broad-ovate or fanlike, stalked, lowest pair usually longest. PINNULES of various shapes and dissections but often fanlike; margins often serrulate. VEINS mostly free, sometimes a few reticulate, forked or fanlike. SORI few, 2-4 per segment, linear or oblong, separate when young, becoming confluent in age, not marginal. INDUSIA broad, laterally attached, with a few hairs. SPORES bilateral.

Withering when dry but recovering in moisture.

Asplenium trichomanes Linnaeus Plate 5

MAIDENHAIR SPLEENWORT

NY, Vt, NH, Me, Mass, Ct, RI, NJ, Pa.

Crevices and other places in rocks of various kinds, moist or dry, open or shaded. Soil acid, pH mostly 5-7.

RHIZOMES short, creeping to erect, 1.5-2 mm in diameter, with many old stipe bases, with scales at the apex. FRONDS not dimorphic, densely clustered, 4-26 cm long, evergreen. STIPE shorter than blade, wiry, purple-brown, shining, sometimes with a few scales, with 1 or 2 circular or oval bundles at base. BLADES linear, 5-20 cm long, 0.8-1.7 cm wide, pinnate; rachis dark. PINNAE opposite or alternate, 9-30 pairs, oval to broad-oblong, unequal-sided but not auriculate, sessile, lowest pair about same length as middle ones; margins crenate or nearly entire. VEINS free, mostly once-forked, not reaching the margin. SORI short, linear, straight, 2-4(-6) per pinna, mostly separate, not marginal. INDUSIA large but fragile, laterally attached. SPORES bilateral.

Asplenium viride Hudson Plate 6

GREEN SPLEENWORT

NY (rare), Vt (rare), Me (rare).

Shaded crevices and among fragments of limy rock. Soil nearly neutral.

RHIZOMES short, creeping to erect, about 1 mm in diameter, with a few scales. FRONDS not dimorphic, clustered, 5-15 cm long, usually evergreen. STIPE shorter than the blade, slender, brown at base, green above, usually with a few scales, with 1 or 2 circular or oval bundles at base. BLADES linear to linear-oblong, mostly 6-13 cm long, 0.5-1.5 cm wide, pinnate; rachis delicate, green, usually with dark hairlike scales. PINNAE opposite or nearly so toward base of blades, alternate above, 9-16 pairs, oval, not auriculate; margins coarsely toothed or lobed. VEINS free, simple or forked, not reaching the margin. SORI linear, straight, 2 or 3 per pinna, confluent, not marginal. INDUSIA fragile, laterally attached. SPORES bilateral.

Athyrium filix-femina (Linnaeus) Roth Plate 7

LADY FERN

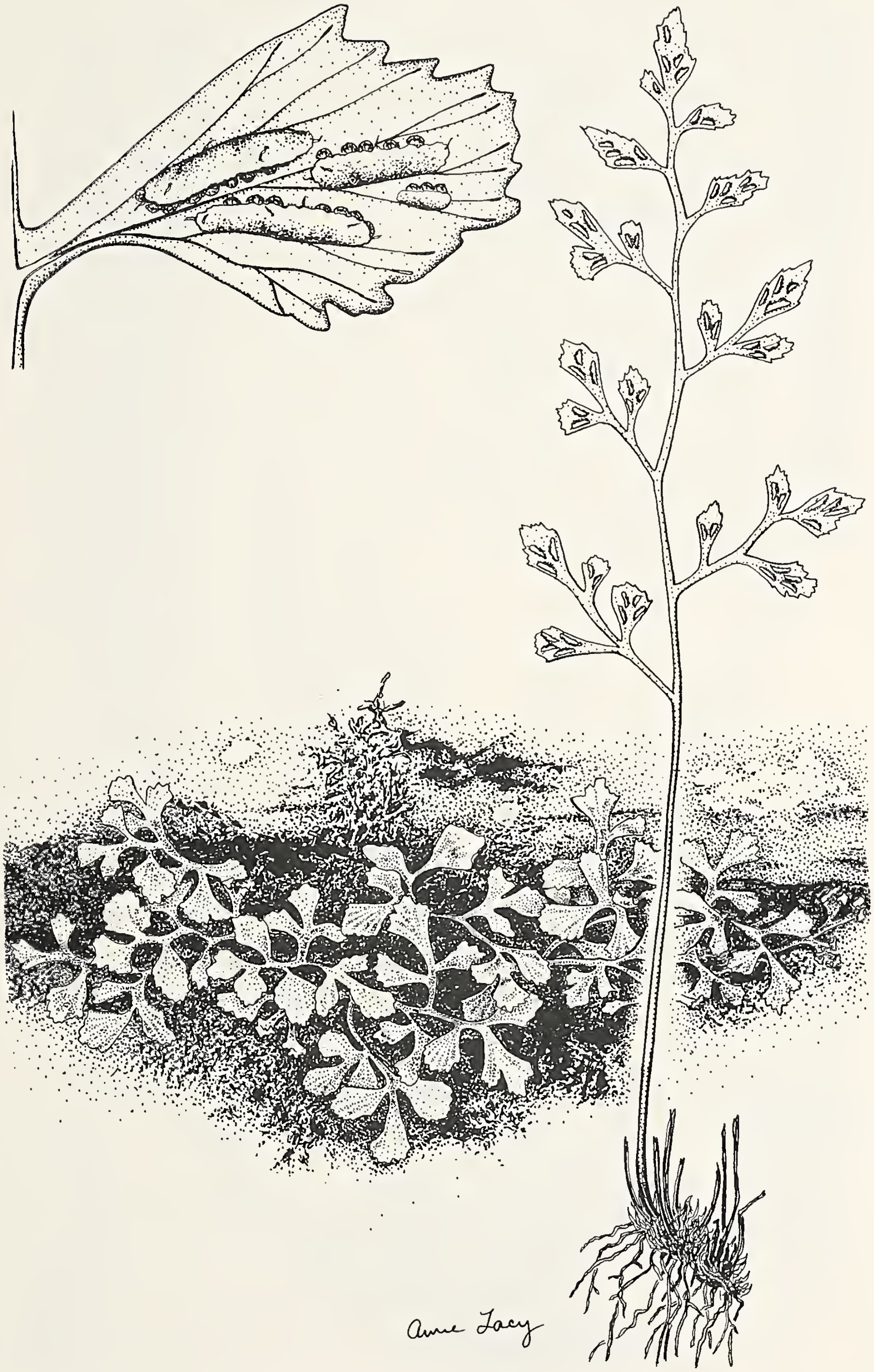
A. angustum, *A. asplenioides*

NY, Vt, NH, Me, Mass, Ct, RI NJ, Pa.

Moist woods, meadows, stream banks, marshes, etc. Soil acid to neutral, pH 5-7.

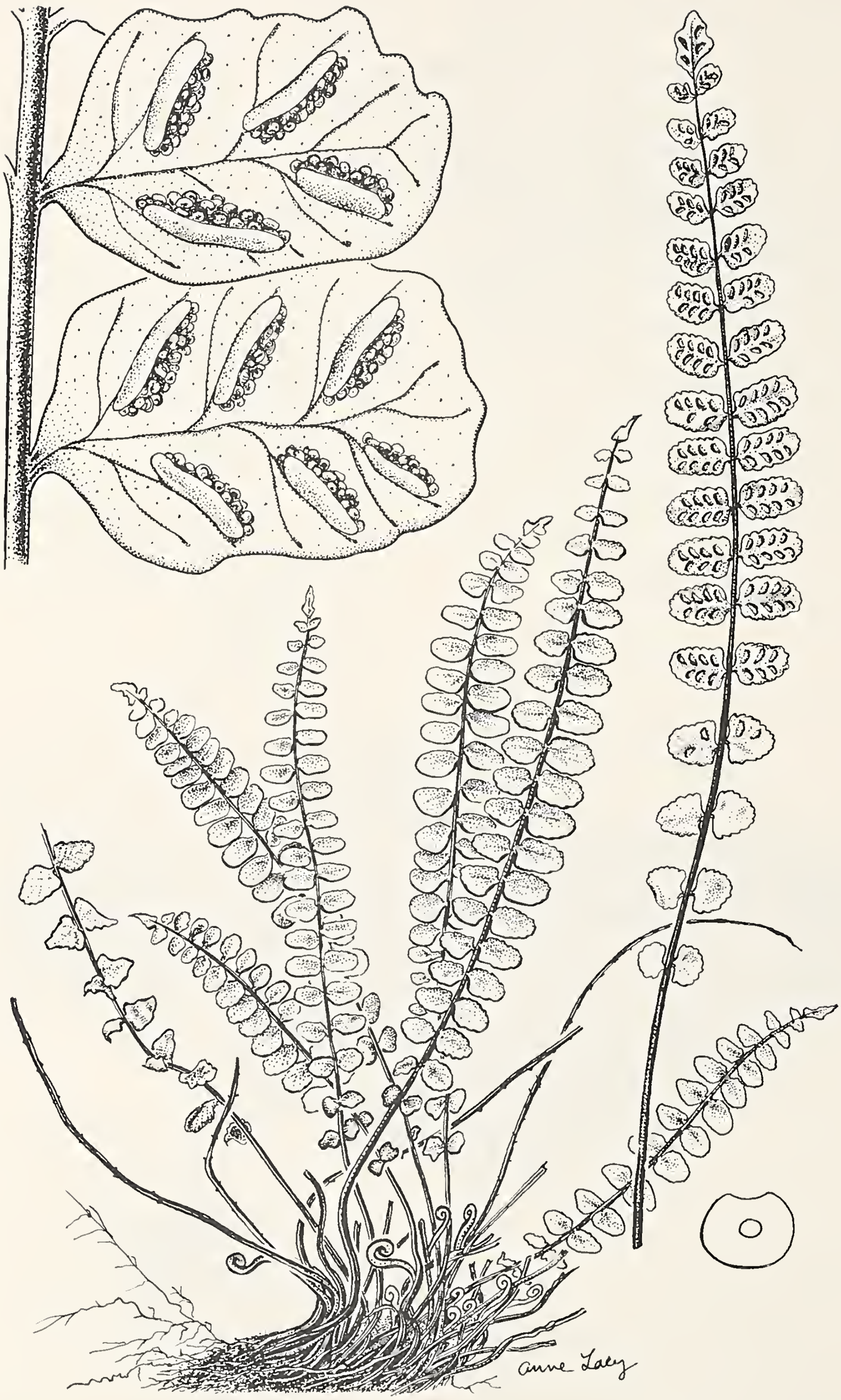
RHIZOMES creeping to nearly erect, about 7 mm in diameter, scaly. CROZIERS round-oblong, 1-2 cm in diameter, densely covered with linear, dark brown or purple scales. FRONDS not dimorphic, coming separately (but near together) from points on the rhizome, (7-)40-90(-100) cm long, not evergreen. STIPE ½ to nearly as long as blade, greenish or reddish, 1-40 cm long, to 6 mm wide, without hairs, with dark brown or purple scales, with 2 curved bundles at base, sometimes united upward. BLADES oblong to lanceolate or ovate-lanceolate, (5-)30-45(-60) cm long, 10-20 (-35) cm wide, bipinnate to bipinnate-pinnatifid (rarely tripinnate); rachis glabrous or with short hairs or scales, green. PINNAE (15-)30-40 pairs, mostly alternate, oblong-lanceolate, with a very short stalk, longest 3-15 cm long, usually 1-4 cm wide, lower pinnae shorter or longer than middle pinnae. PINNULES mostly 20-30 pairs, mostly alternate but often opposite at base, oblong, usually glabrous; margins lobed or toothed. VEINS free, forked, reaching the margin. SORI not marginal, linear, straight or curved, usually hooked at one end, usually 3-10 per segment, separate or semi-confluent with age. INDUSIA laterally attached, ciliate, sometimes glandular. SPORES bilateral.

Plate 4



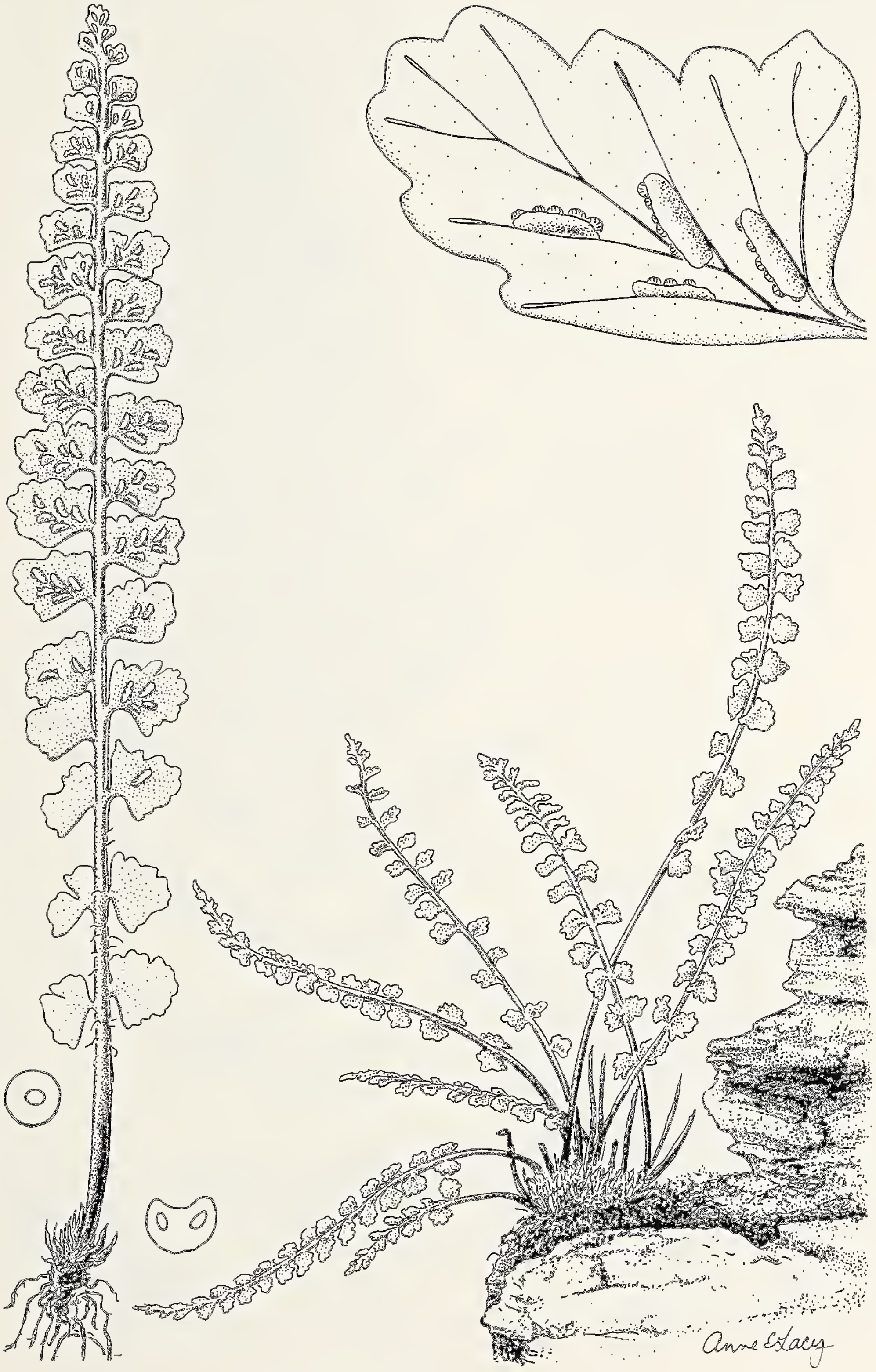
Asplenium ruta-muraria WALL RUE

Plate 5



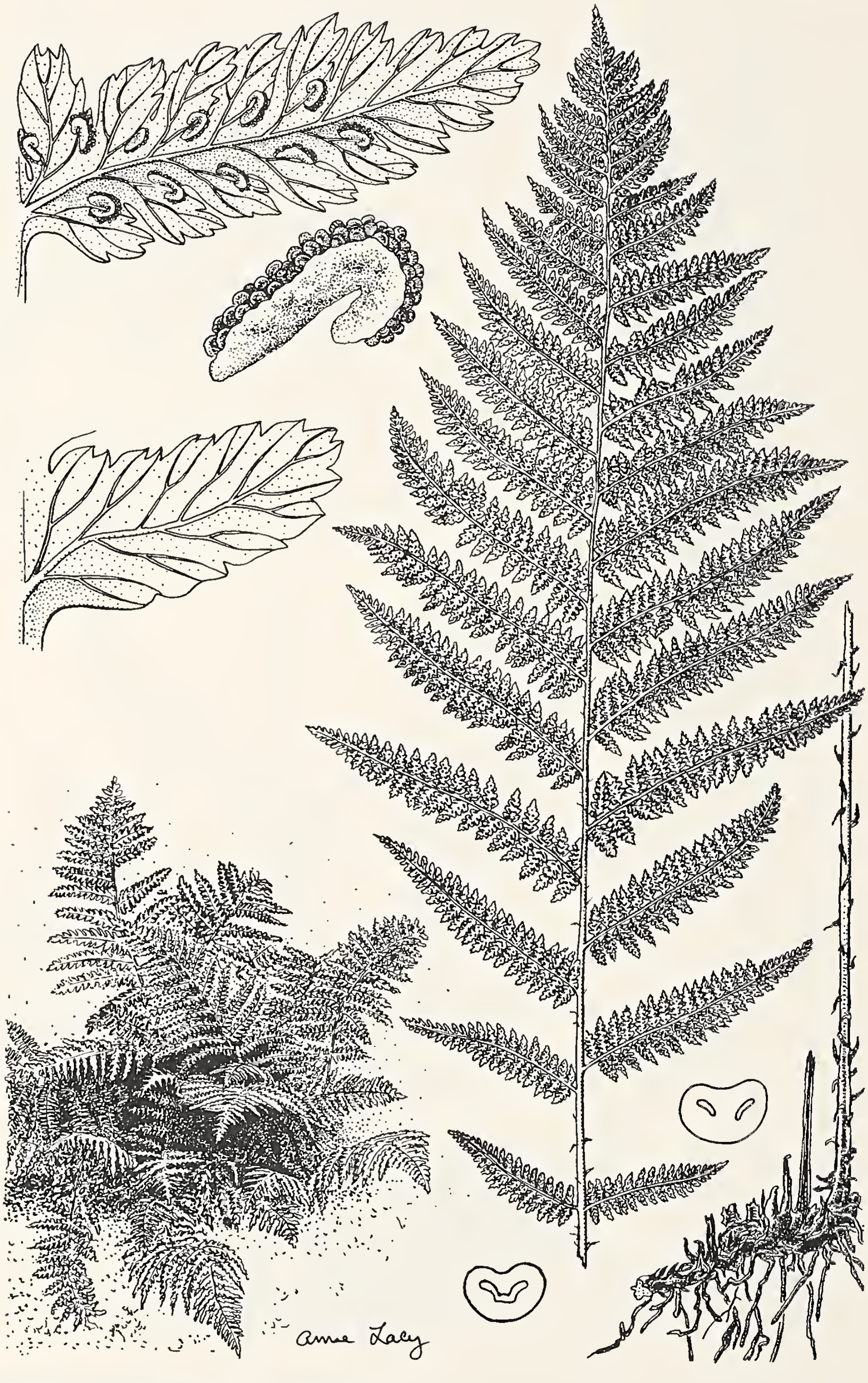
Asplenium trichomanes MAIDENHAIR SPLEENWORT

Plate 6



Asplenium viride GREEN SPLEENWORT

Plate 7



Athyrium filix-femina LADY FERN

Athyrium pycnocarpon (Sprengel) Tidestrom Plate 8

GLADE FERN, NARROW-LEAVED SPLEENWORT

Diplazium pycnocarpon

NY, Vt, NH, Mass, Ct, NJ, Pa.

Cool woods, glades, talus slopes. Soil about neutral to alkaline, pH 7-8(-9).

RHIZOMES creeping, 4-6 mm in diameter, scaly. FRONDS not or slightly dimorphic, fertile pinnae narrower than sterile pinnae, solitary or clustered, 60-110 cm long, not evergreen. STIPE about ½ as long as blade, 15-40 cm long, hairy (at least when young), scaly at bases, with 2 curved bundles at base, often united upward. BLADES lanceolate with long, narrow apex, 25-75 cm long, 10-25 cm wide, pinnate; rachis pale green, with a few brown hairs but no scales. PINNAE 20-30 pairs, mostly alternate, long-acuminate, nearly linear, rounded to semi-hastate at base but not auriculate, sessile or the lowest ones with very short stalks, longest 7-12 cm long, lower pinnae shorter than middle pinnae, glabrous except on veins; margins entire. VEINS free, once or twice forked, reaching the margin. SORI not marginal, linear, straight or slightly curved, silvery green when young, about 20-40 per pinna, separate. INDUSIA laterally attached, conspicuous, glabrous. SPORES bilateral.

Somewhat resembles *Polystichum acrostichoides* but pinnae not auriculate.

Athyrium thelypterioides (Michaux) Desvaux Plate 9

SILVERY SPLEENWORT

Diplazium acrostichoides

NY, Vt, NH, Me, Mass, Ct, RI, NJ, Pa.

Rich, moist woods, stream banks, marshy ground. Soil acid, pH 5-6(-7).

RHIZOMES creeping, 5-7 mm in diameter, scaly. FRONDS not (or slightly) dimorphic, coming separately (but near together) from the rhizome, (35-)60-110 cm long, not evergreen. STIPE ½-⅔ as long as the blade, (10-)25-40(-75) cm long, with a few hairs, scaly at bases, with 2 curved bundles at base, often united upward. BLADES lanceolate to elliptic, tapering at both ends, 35-80 cm long, (6-)10-20(-30) cm wide, pinnate-pinnatifid to nearly bipinnate; rachis pale green, with hairs and narrow scales (at least when young). PINNAE 15-20 pairs, opposite and alternate, oblong to linear-lanceolate with acuminate apex, sessile, 0.7-2 cm long, about 0.4 cm wide, lowest pinnae shorter than middle pinnae and usually pointing downward; segments oblong, obtuse or acute at apex, with yellowish hairs and a few scales; margins entire or serrulate. VEINS free, rarely forked, reaching the margin. SORI not marginal, linear, straight or slightly curved, 3-7 per segment, separate, but sometimes close together. INDUSIA laterally attached, arching, silvery when young, light brown in age. SPORES bilateral.

Azolla caroliniana Willdenow Plate 10

MOSQUITO FERN

NY, Mass, Ct (?), NJ (?), Pa (?). Occasionally introduced but in many areas it may not long persist.

Floating on quiet water.

Small (5-10 mm wide) mosslike plants. RHIZOMES branched at every third leaf. LEAVES with 2 lobes, upper smaller lobe floating and lower larger lobe submersed, greenish or reddish. SPOROCARPS (sporangia) of 2 kinds, in the leaf axils. The smaller sporocarps contain a single large megaspore. The larger sporocarps contain many tiny microspores. These sporocarps are seldom seen in our area.

A. *filiculoides* is sometimes reported but probably does not persist. High magnification is needed for separating species of *Azolla*.

Botrychium dissectum Sprengel Plate 11

LACE-LEAF GRAPE FERN

B. obliquum

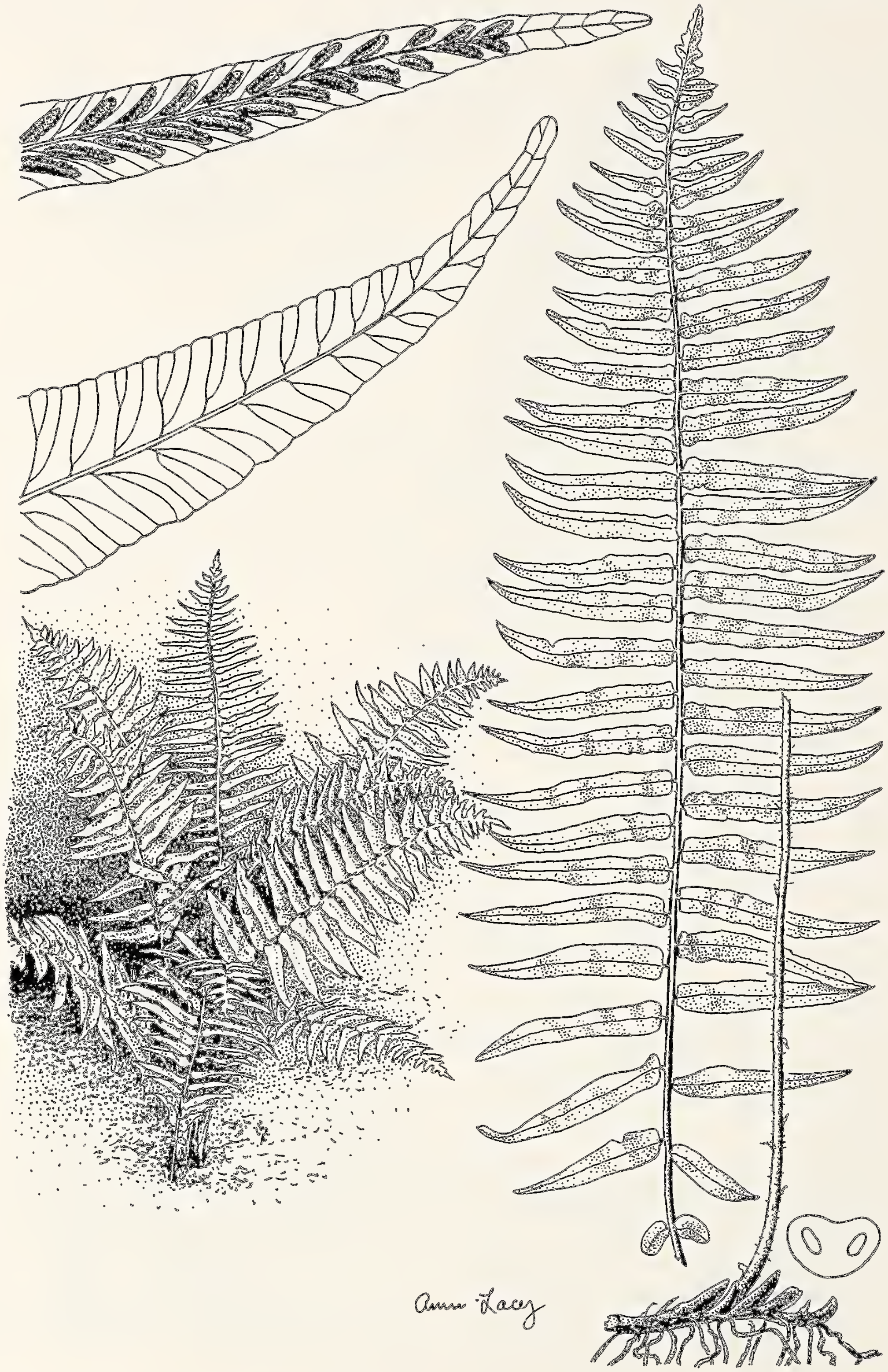
NY, Vt, NH, Me, Mass, Ct, RI, NJ, Pa.

Dry or moist woods, fields, pastures, sandy banks. Soil usually acid.

FRONDS dimorphic, solitary, 10-50 cm long, dwarf forms (½ size) occur with normal ones, appearing late summer, evergreen but often becoming bronze after freezing weather. COMMON STIPE 0.5-6 cm long, bearing a sterile and a fertile blade, glabrous or with a few hairs, usually with 1 linear, curved bundle in the shape of a nearly closed ring, sometimes divided into 2-4 upward. STERILE BLADE membranous or slightly leathery, ovate to broad-triangular, 4-8 cm long, 3-12 cm wide, with a stalk 2.5-8 cm long, pinnate-pinnatifid to quadripinnate. STERILE PINNAE opposite, lowest pair longer than middle pairs, glabrous or with a few hairs; margins wavy or with tiny short teeth. VEINS free, forked. FERTILE BLADE 2-14 cm long, on a stalk longer than the common stipe, bipinnate to quadripinnate, mostly tripinnate. SPORANGIA globular, clustered. SPORES tetrahedral.

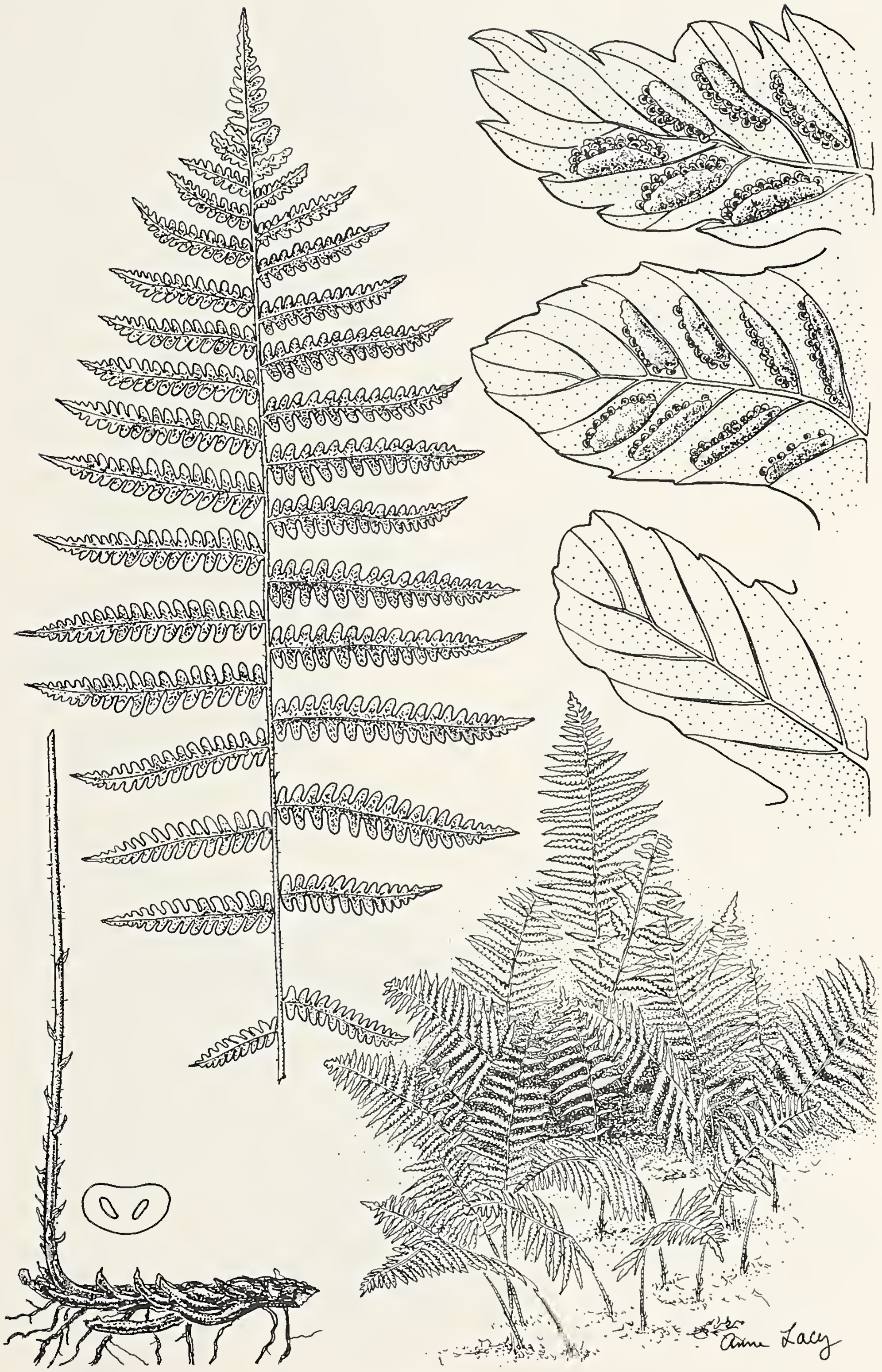
A highly variable species. The variants are recognized as varieties by some and as distinct species by others.

Plate 8



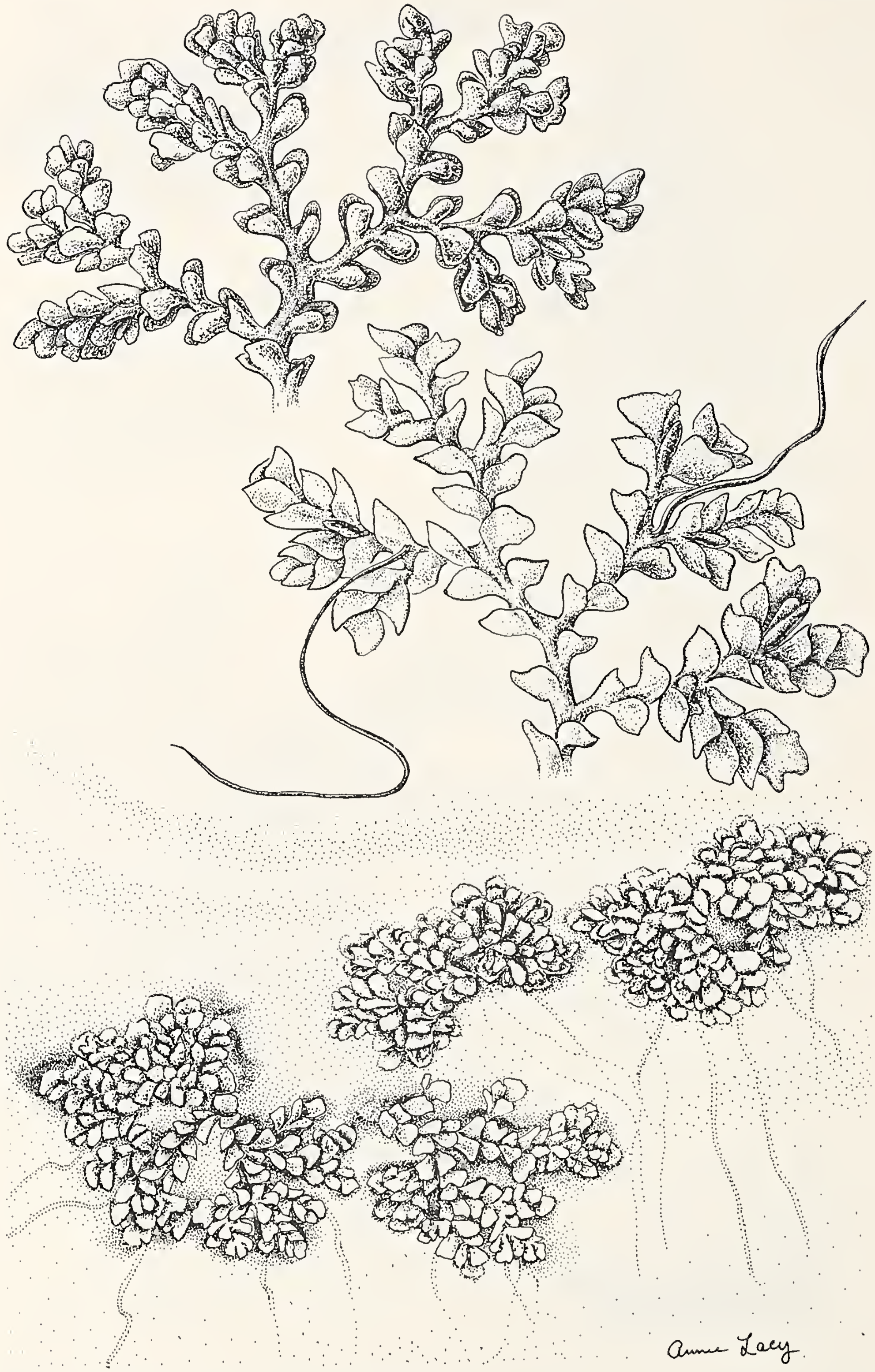
Athyrium pycnocarpon GLADE FERN

Plate 9



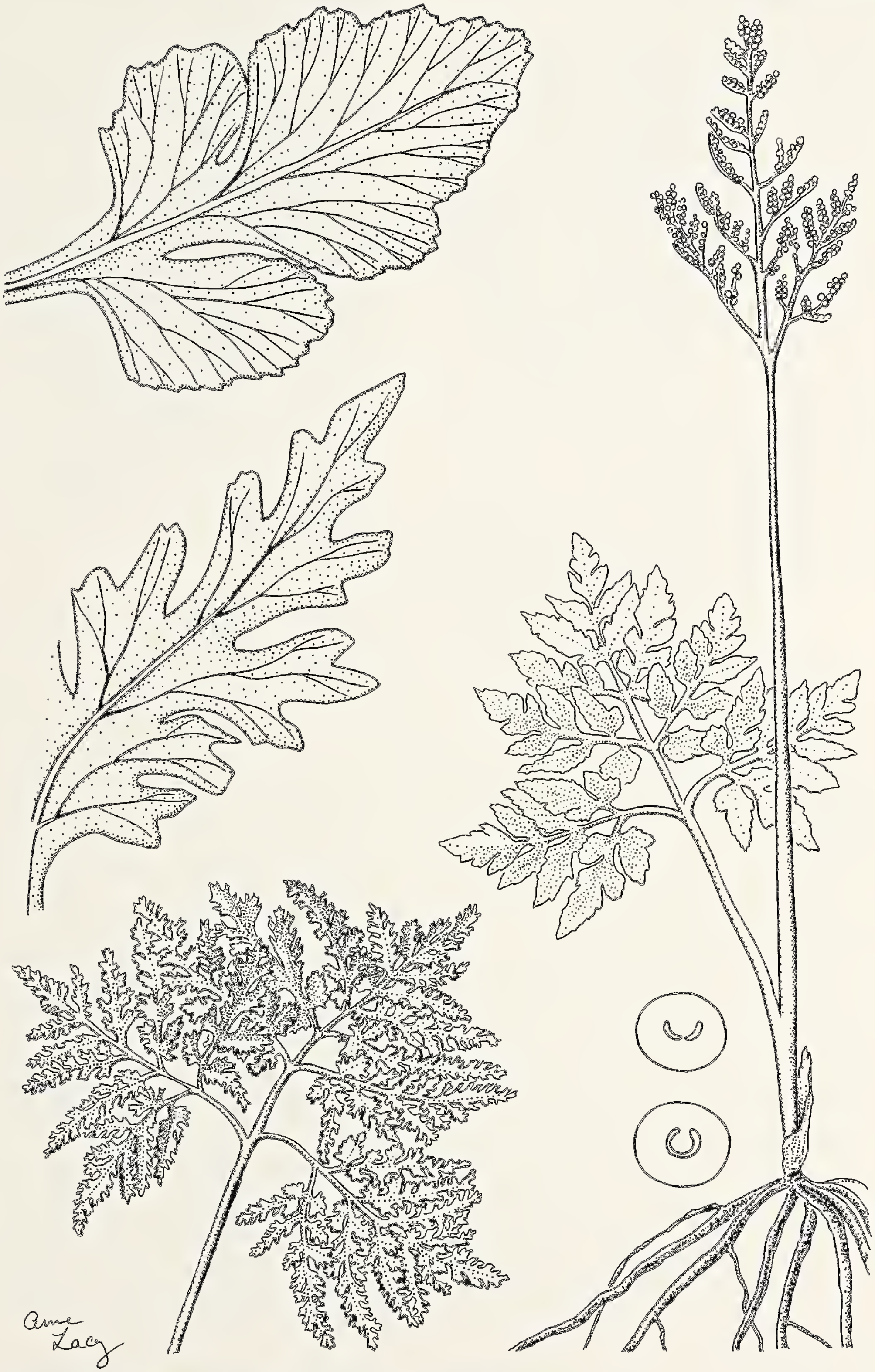
Athyrium thelypterioides SILVERY SPLEENWORT

Plate 10



Azolla caroliniana MOSQUITO FERN

Plate 11



Botrychium dissectum LACE-LEAF GRAPE FERN

Botrychium lanceolatum (Gmelin) Angström Plate 12

LANCE-LEAVED GRAPE FERN

B. angustisegmentum

NY, Vt, NH, Me, Mass, Ct, RI, NJ, Pa.

Rich soil of moist, cool woods, hummocks, in swamps, meadows, etc. Soil acid, pH usually 4-6.

FRONDS dimorphic, solitary, 5-25(-40) cm long, dwarf forms (½ size) occur with normal ones, found spring through summer, not evergreen. COMMON STIPE 6-20 cm long, often 5 times as long as sterile blade, glabrous, with 2 or more linear, curved bundles arranged in a ring. STERILE BLADE thin or somewhat leathery (sometimes thick and fleshy in the northern parts of our area), triangular, 1-5 cm long, 1.5-4 cm wide, sessile or with a stalk up to 0.6 cm long, pinnate-pinnatifid or bipinnate. STERILE PINNAE opposite, lowest pair longest, glabrous, margins entire. VEINS free, forked. FERTILE BLADES 0.1-1.3 cm long, on a stalk shorter than the common stipe, bipinnate to tripinnate. SPORANGIA globular, clustered, greenish yellow. SPORES tetrahedral, yellowish.

Botrychium lunaria (Linnaeus) Swartz Plate 13

MOONWORT

NY (rare), Vt (rare), NH (rare), Me (rare).

Open fields and slopes, grassy meadows, limestone barrens and woods. Soil neutral or nearly so.

FRONDS dimorphic, solitary, 4-25 cm long, appearing during early spring, withering in summer, not evergreen. COMMON STIPE 1.5-4(-7) cm long, bearing a sterile and a fertile blade, glabrous, with 1 or more bundles arranged in a ring. STERILE BLADE thin or leathery, oblong, 1-6 cm long, 1-3 cm wide, sessile or with a stalk, pinnate. STERILE PINNAE opposite, (2-)3-7(-10) pairs, each pair about equal in size, fanlike or lunate, cuneate at bases, rounded at apex; margins mostly entire, sometimes notched or crenate. VEINS free, forked. FERTILE BLADE on a stalk longer or shorter than the common stipe, pinnate to tripinnate. SPORANGIA globular, clustered. SPORES tetrahedral, yellowish.

Botrychium minganense Victorin, MINGAN MOONWORT, is recognized as a species distinct from *B. lunaria* by some modern authorities on ferns. Both are rare with us and they are not easily distinguished.

Botrychium matricariifolium (Döll) A. Braun Plate 14

DAISY-LEAF GRAPE FERN

B. neglectum

NY, Vt, NH, Me, Mass, Ct, RI, NJ, Pa.

Rich woods, swamps, moist shaded slopes. Soil acid to neutral, pH 4-7.

FRONDS dimorphic, solitary, 7-30 cm long, found during spring and early summer, not evergreen. COMMON STIPE 6-16 cm long, bearing a sterile and a fertile blade, glabrous, with 2 bundles at base and 2-6 upward. STERILE BLADE thin or slightly leathery, oblong or narrowly triangular, 1.5-6 cm long, 1-4 cm wide, with a stalk 0.2-1.5 cm long, pinnate to pinnate-pinnatifid. STERILE PINNAE opposite or nearly so, lowest pair longer than middle pairs, glabrous; margins entire. VEINS free, forked. FERTILE BLADE 1-7 (-10) cm long, on a stalk shorter than the common stipe, pinnate to tripinnate. SPORANGIA globular, clustered, bright yellow. SPORES tetrahedral, yellowish.

Botrychium multifidum (Gmelin) Ruprecht Plate 15

LEATHERY GRAPE FERN

B. matricariae, B. silaifolium

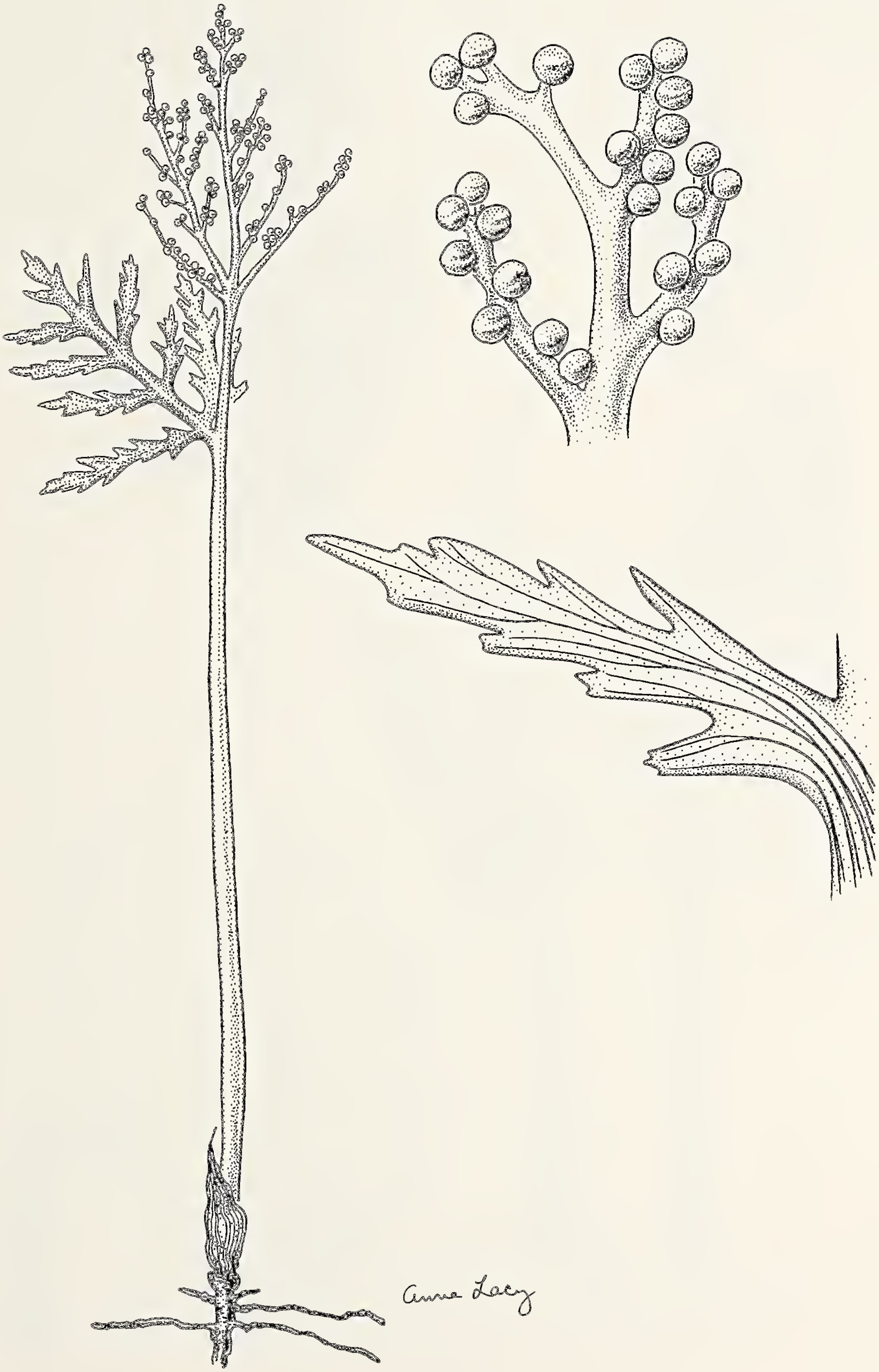
NY, Vt, NH, Me, Mass, Ct, RI, NJ, Pa.

Cool meadows, open fields, moist woods. Soil acid, pH usually 5-6.

FRONDS dimorphic, solitary, 4-25(-50) cm long, dwarf forms occur with normal ones, appearing during spring or early summer, evergreen and usually remaining green after freezing weather. COMMON STIPE 1-5(-8) cm long, bearing a sterile and a fertile blade, glabrous or with a few hairs, usually with 1 linear, curved bundle in the shape of a nearly closed ring, sometimes divided into 2-4 upward. STERILE BLADE leathery and fleshy, triangular, 1-15 cm long, 1-25 cm wide, on a stalk 3-15 cm long, bipinnate to quadripinnate. STERILE PINNAE opposite, lowest pair longer than middle pairs, with a few hairs. STERILE PINNULES usually less than twice as long as wide; margins entire to dentate. VEINS free, forked. FERTILE BLADE 1.2-12(20) cm long, on a stalk longer than the common stipe, bipinnate to tripinnate. SPORANGIA globular, clustered. SPORES tetrahedral, yellowish.

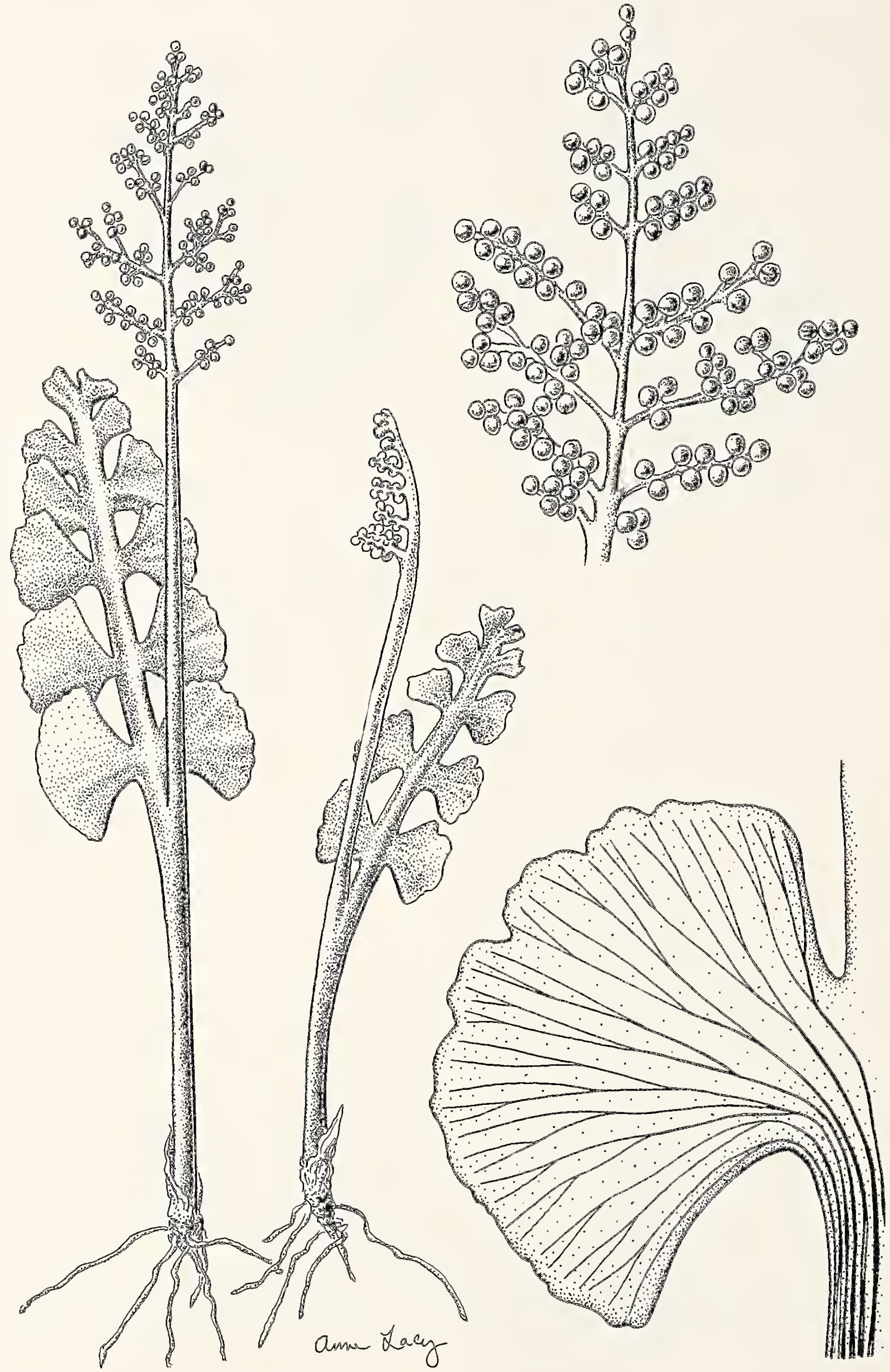
A highly variable species.

Botrychium ternatum (Thunberg) Swartz is recognized as a distinct species by some modern authorities on ferns. It is rare and not easily distinguished from *B. multifidum*.



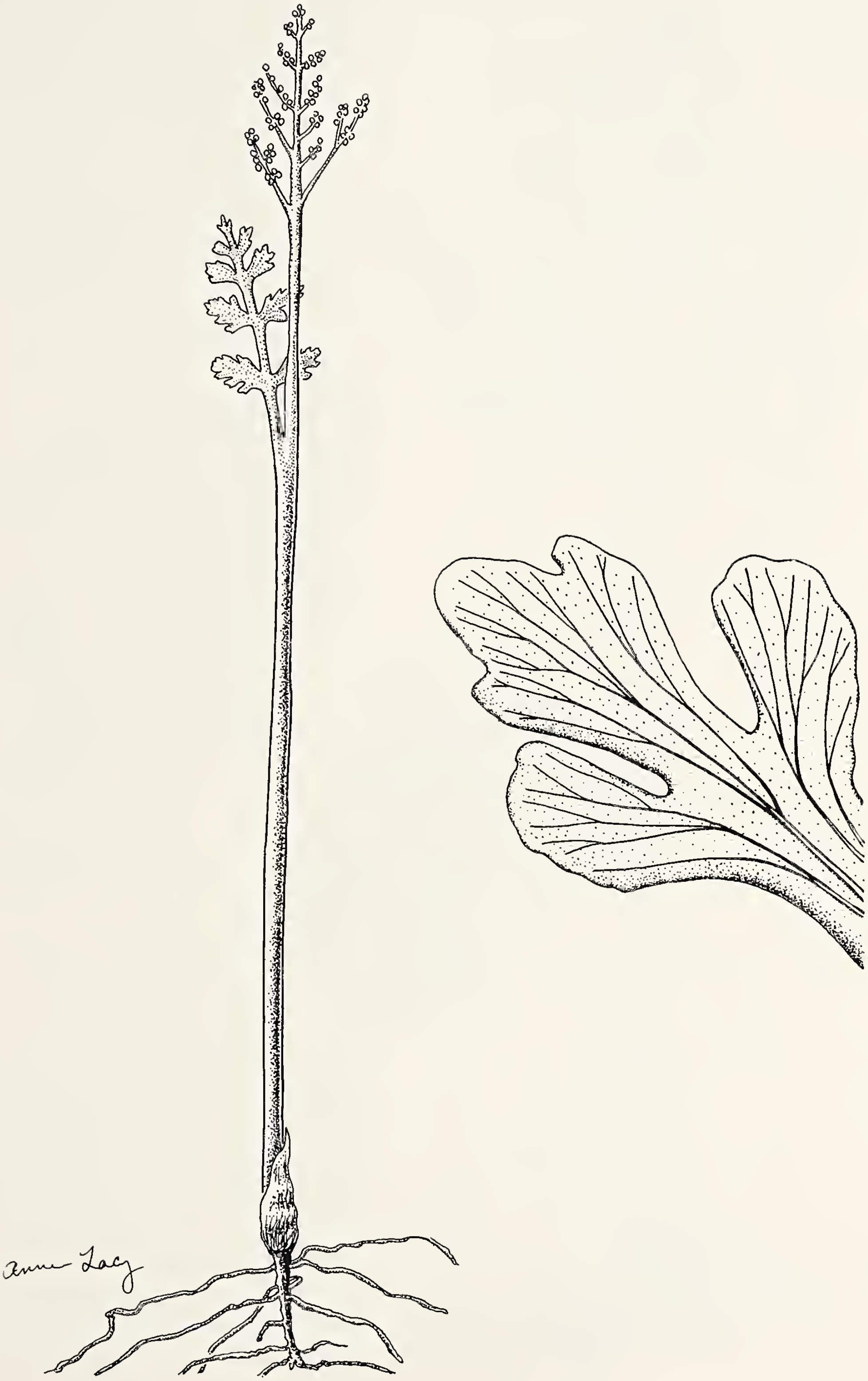
Botrychium lanceolatum LANCE-LEAVED GRAPE FERN

Plate 13



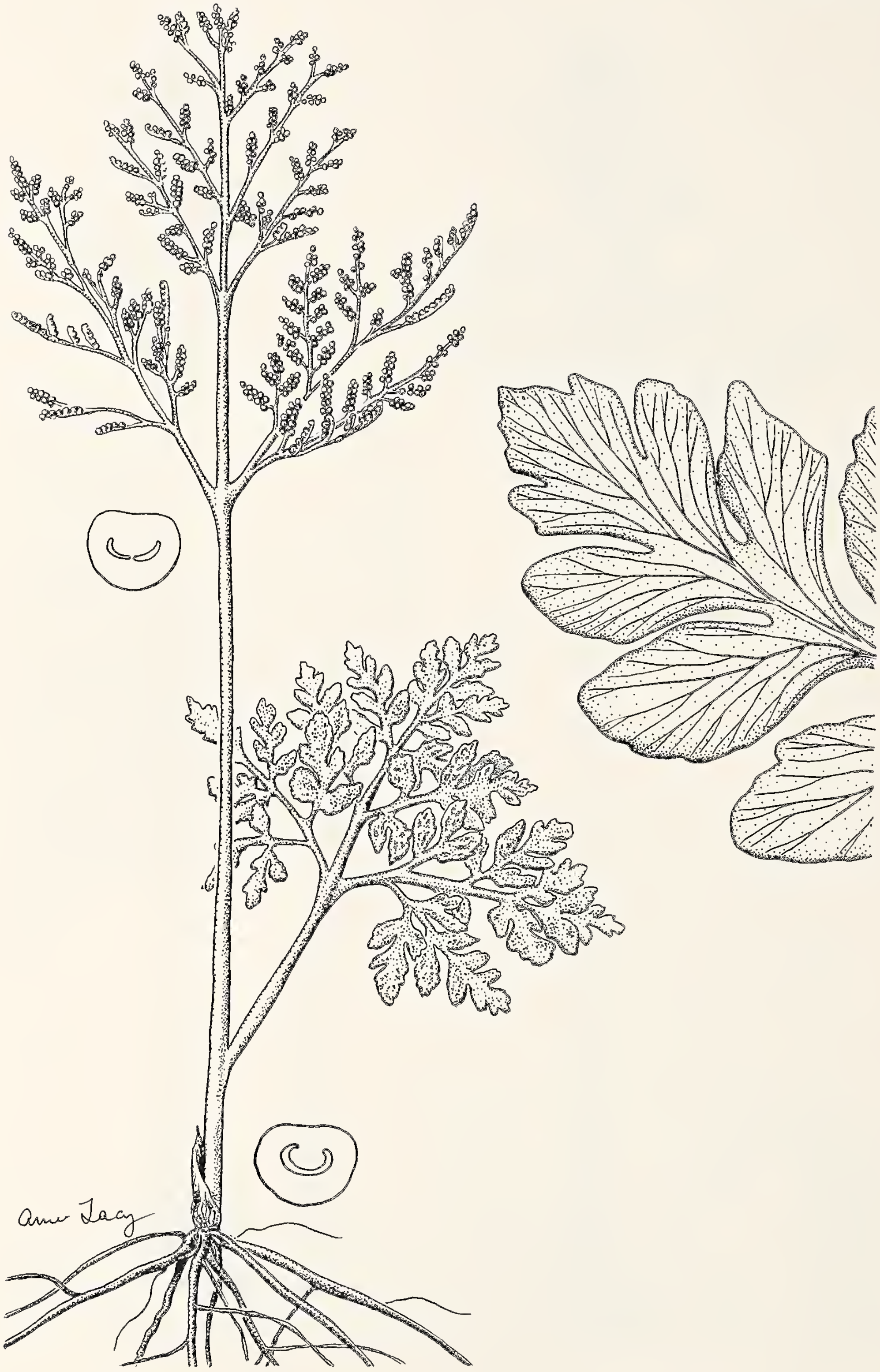
Botrychium lunaria MOONWORT

Plate 14



Botrychium matricariifolium DAISY-LEAF GRAPE FERN

Plate 15



Botrychium multifidum LEATHERY GRAPE FERN

Botrychium oneidense (Gilbert) House Plate 16

ONEIDA GRAPE FERN

B. dissectum forma *oneidense*, *B. multifidum* var. *oneidense*, *B. dissectum* × *multifidum*

NY, Vt, NH, Me, Mass, Ct, RI, NJ, Pa.

Moist or wet woods. Soil acid.

FRONDS dimorphic, solitary, 10-45 cm long, evergreen and usually remaining bright green after freezing weather. COMMON STIPE 2-4 cm long, bearing a sterile and a fertile blade, glabrous or with a few hairs, usually with 1 linear curved bundle in the shape of a nearly closed ring, sometimes divided, 2-4 upward. STERILE BLADE leathery and fleshy, triangular, mostly 5-10 cm long, 6-12 cm wide, with a stalk 5-10 cm long, ternate, bipinnate to tripinnate. STERILE PINNAE opposite, lowest pair longer than middle pairs, glabrous or with a few hairs. STERILE PINNULES 2-3 times as long as wide, obtuse at apex; margins irregularly toothed. VEINS free, forked. FERTILE BLADE 2-20 cm long, on a stalk longer than the common stipe, mostly tripinnate. SPORANGIA globular, clustered. SPORES tetrahedral.

Easily confused with two highly variable species, *B. multifidum* and *B. dissectum*, often appearing to be a blend between the two. From *B. multifidum* it is distinguished by the pinnule lobes or segments being only about as long as wide and from *B. dissectum* by the pinnules being obtuse at apex.

Botrychium simplex E. Hitchcock Plate 17

DWARF GRAPE FERN

B. tenebrosum

NY, Vt, NH, Me, Mass, Ct, RI, NJ, Pa.

Cool woods and swamps, meadows, open sterile northfacing slopes. Soil acid, pH usually 5-6.

FRONDS dimorphic, solitary, 2-25 cm long, appearing during early spring, withering by midsummer, not evergreen. COMMON STIPE 1.5-13 cm long, bearing a sterile and a fertile blade, glabrous, with 1 or more bundles arranged in a ring. STERILE BLADE thin or leathery, ovate or oblong, 0.5-4 cm long, 0.2-3 cm wide, stalk 0.5-2 cm long, mostly pinnate, sometimes only pinnatifid, rarely ternate or bipinnate. STERILE PINNAE opposite or nearly so, 1-4(-5) pairs, each pair about equal in size, fanlike, cuneate at base, rounded at apex; margins entire, sometimes lobed. VEINS free, forked. FERTILE BLADE on a stalk longer or shorter than the common stipe, simple or pinnate or bipinnate. SPORANGIA globular, clustered. SPORES tetrahedral, yellowish.

Botrychium virginianum (Linnaeus) Swartz Plate 18

RATTLESNAKE FERN, VIRGINIA GRAPE FERN

NY, Vt, NH, Me, Mass, Ct, RI, NJ, Pa.

Moist or dry woods, swamps, meadows. Soil acid to neutral, pH usually 5-7.

FRONDS dimorphic, solitary, 25-75 cm long, dwarf forms (½ size) are frequent, appearing spring to fall, not evergreen. COMMON STIPE 7-35 cm long, each bearing a sterile and usually a fertile blade, with a few hairs, with 2 or more bundles, often with 2 linear, curved bundles and 2 circular bundles. STERILE BLADE thin, not leathery, triangular, 4-30 cm long, 4-40 cm wide, sessile or nearly so, bipinnate-pinnatifid to nearly tripinnate. STERILE PINNAE opposite, lowest pair longer than middle pairs, usually with a few hairs; margins with teeth. VEINS free, mostly once-forked. FERTILE BLADE 2-18 cm long, on a stalk about same length as the common stipe, bipinnate to tripinnate. SPORANGIA globular, clustered. SPORES tetrahedral, yellowish or cream-colored.

The largest and commonest of our species of *Botrychium*. The fertile blade is often absent, but evidence of it usually appears as a short stub.

Camptosorus rhizophyllus (Linnaeus) Link Plate 19

WALKING FERN

Asplenium rhizophyllus

NY, Vt, NH, Me (rare or extinct), Mass, Ct, RI (rare), NJ, Pa.

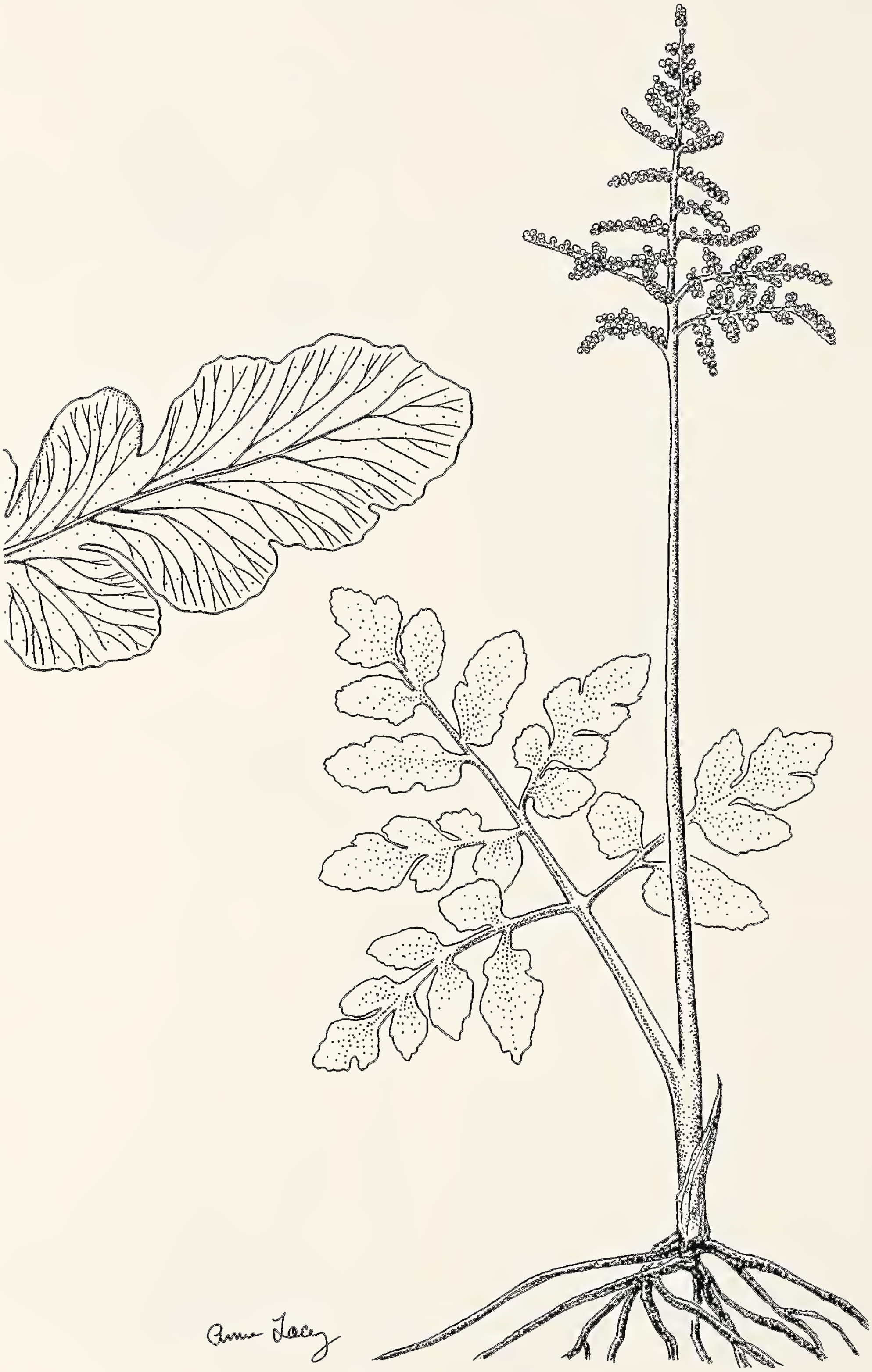
On thin soil on rocks, crevices in cliffs, on talus slopes, etc. Does best on limy rock but found also on other rocks. Soil usually about neutral.

RHIZOMES short, erect, about 2 mm in diameter, scaly. FRONDS not dimorphic, clustered, 5-20 cm long, evergreen. STIPES variable in length, dark brown and scaly at base, green and without scales above, with 2 bundles at base, united upward. BLADES lance-linear, cordate at base, with a long tapering apex, (5-)10-30 cm long, (1-)1.5-3 cm wide at base, not dissected, lobed at base, without hairs or scales; margins entire. VEINS reticulate, the outer ones free, not reaching the margin. SORI linear, not marginal, borne along the veins. INDUSIA large, laterally attached. SPORES bilateral.

Often rooting at the apex of the blade, which is sometimes forked.

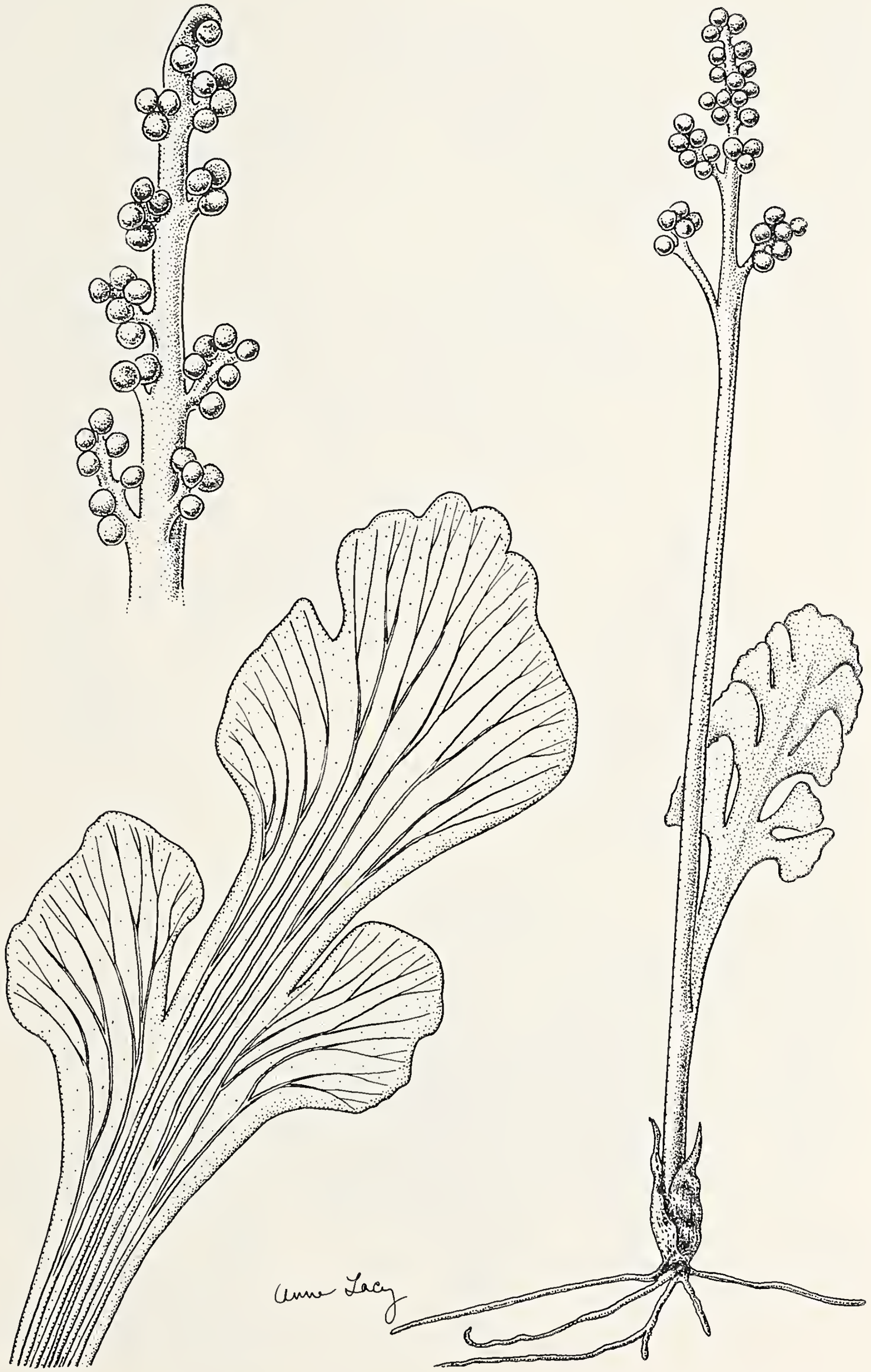
Closely related to *Asplenium* species, with several of which it may form hybrids. These hybrids are by some placed in the genus *Asplenosorus*.

Plate 16



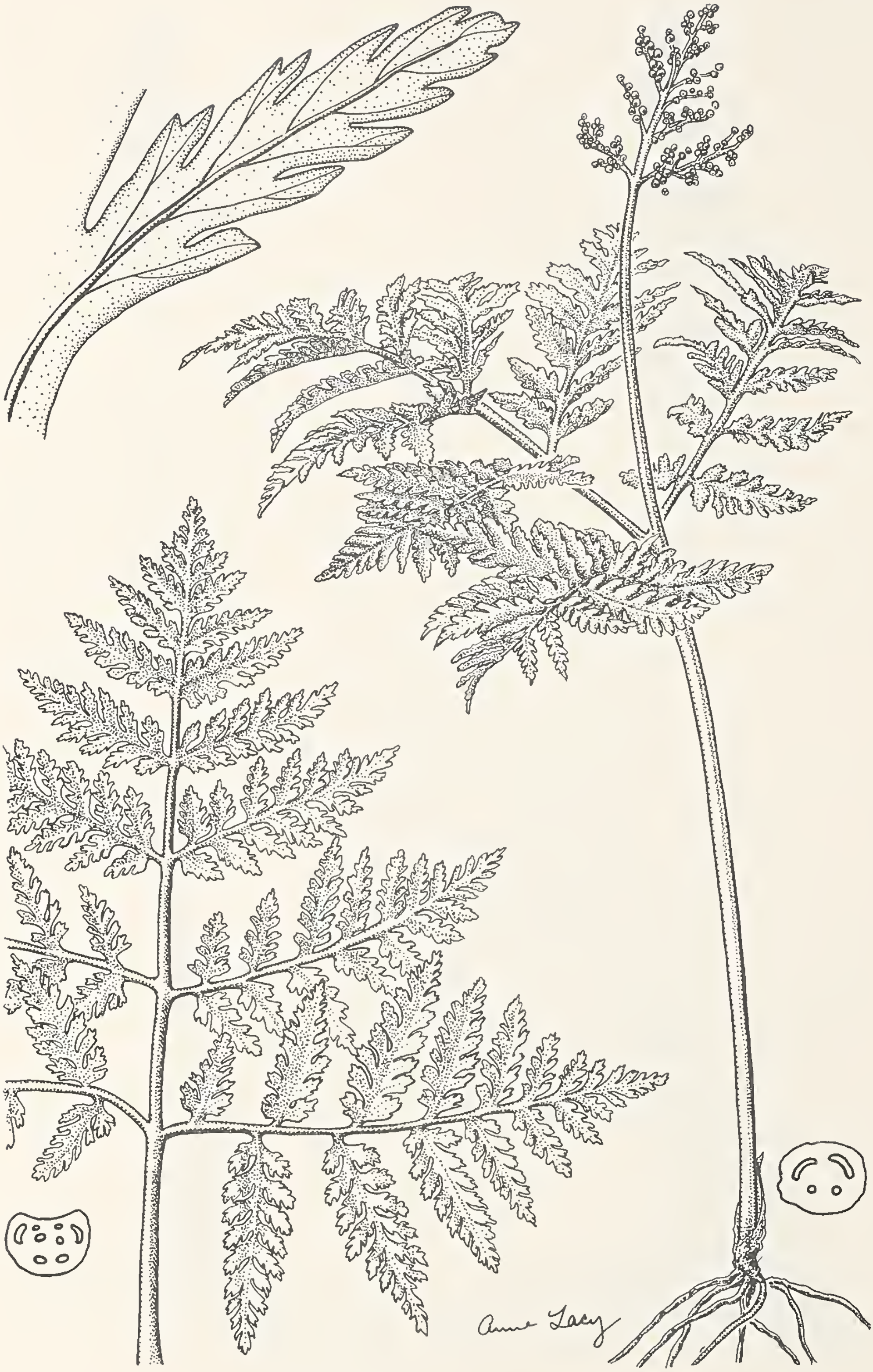
Botrychium oneidense ONEIDA GRAPE FERN

Plate 17



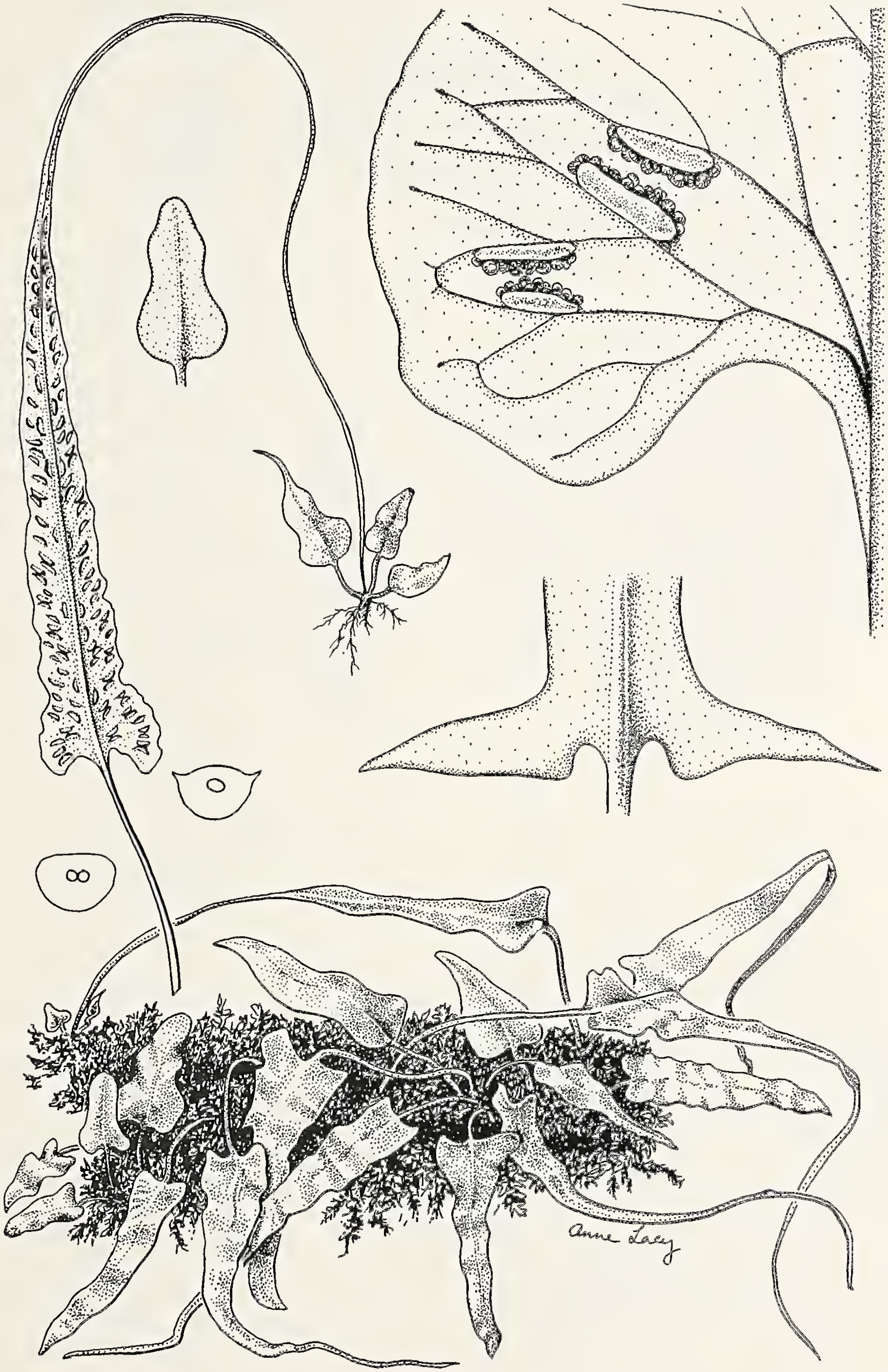
Botrychium simplex DWARF GRAPE FERN

Plate 18



Botrychium virginianum RATTLESNAKE FERN

Plate 19



Camptosorus rhizophyllus WALKING FERN

Cheilanthes lanosa (Michaux) D. C. Eaton Plate 20

HAIRY LIP FERN

C. vestita

NY (rare), Ct (rare), NJ, Pa.

Dry rocky slopes and cliffs. Soil mostly acid, sometimes neutral, or even slightly alkaline.

RHIZOMES branched, scaly, without hairs. FRONDS not dimorphic, with several clusters from points on the rhizome, 10-30 cm long, evergreen. STIPE shorter than the blade, 2-8 cm long, slender, wiry, dark brown, with dense, septate, brownish hairs but no scales, with 1 curved bundle (rarely 2). BLADES oblong-lanceolate, 8-30 cm long, 2-7 cm wide, bipinnate to tripinnate, mostly bipinnate-pinnatifid; rachis with hairs like those on the stipe, without scales. PINNAE opposite or subopposite below, mostly alternate above, 12-20 pairs, deltoid-lanceolate to ovate-oblong, widely spaced below, crowded upward. PINNULES 7-10 pairs on a pinna, hairy on both sides; margins lobed but entire. VEINS free, mostly forked at the ends, not reaching the margin. SORI marginal or nearly so, at the ends of the veins, circular to oblong. INDUSIA only the reflexed, unmodified, green margin of the pinnule. SPORES tetrahedral.

The blades may shrivel during dry weather but revive after rain.

Cryptogramma stelleri (Gmelin) Prantl Plate 21

SLENDER CLIFF BRAKE

NY, Vt, NH (rare), Me (rare), Mass (rare), Ct (rare), NJ, Pa. Often rare or overlooked.

Cool, moist, shady ledges of limestone or other calcareous rock. Soil neutral to alkaline.

RHIZOMES slender, 0.5-1 mm in diameter, hairy, scaly. FRONDS dimorphic, rising from separate points on the rhizome, not evergreen; sterile fronds 7-15 cm long, fertile fronds longer. STIPES of both usually longer than their blades, hairy at base, glabrous above, with 1 tiny circular or slightly curved bundle. STERILE BLADES ovate, 3-6(-8) cm long, 2-5(-6) cm wide, pinnate-pinnatifid to bipinnate (sometimes bipinnate-pinnatifid); rachis greenish, without hairs or scales. STERILE PINNAE 5-6 pairs, alternate or opposite, lowest longest. STERILE PINNULES 1-3 pairs per pinna; margins entire or toothed. VEINS free, forked, not reaching the margin. FERTILE BLADES ovate, bipinnate to tripinnate or quadripinnate. FERTILE PINNULES linear-lanceolate. SORI marginal, circular to linear. True INDUSIA absent; leaf margin forms a false indusium when young—opens flat in age. SPORES tetrahedral.

Cystopteris bulbifera (Linnaeus) Bernhardi Plate 22

BULBLET BLADDER FERN

Filix bulbifera

NY, Vt, NH, Me, Mass, Ct, RI, NJ, Pa.

Wet, shaded rocks, ledges, ravines, talus slopes, limestone and calcareous shales, sometimes hummocks in limy swamps. Soil neutral to alkaline, pH usually 7-9.

RHIZOMES with a few brown scales. FRONDS not dimorphic, usually clustered, 30-80(-150) cm long, not evergreen. STIPE shorter than the blade, slender, mostly glabrous, pinkish, with a few scales at base, with 2 oval or oblong bundles at base, these united near the blade or in the rachis. BLADES narrowly triangular to linear-lanceolate, long-tapering, 25-45 cm long, 6-15 cm wide, pinnate-pinnatifid to bipinnate-pinnatifid; rachis glabrous or with a few hairs, with bulblets usually present on the under side. PINNAE 20-40 pairs, nearly opposite at base, becoming alternate upward, basal pinnae slightly longer than next pair above. PINNULES or segments glabrous or with a few hairs; margins denticulate. VEINS free, forked or not, mostly running to the sinuses between the teeth. SORI few, not marginal, circular, separate. INDUSIA laterally attached, hoodlike. SPORES bilateral, spiny.

Cystopteris fragilis (Linnaeus) Bernhardi Plate 23

FRAGILE FERN, BRITTLE FERN

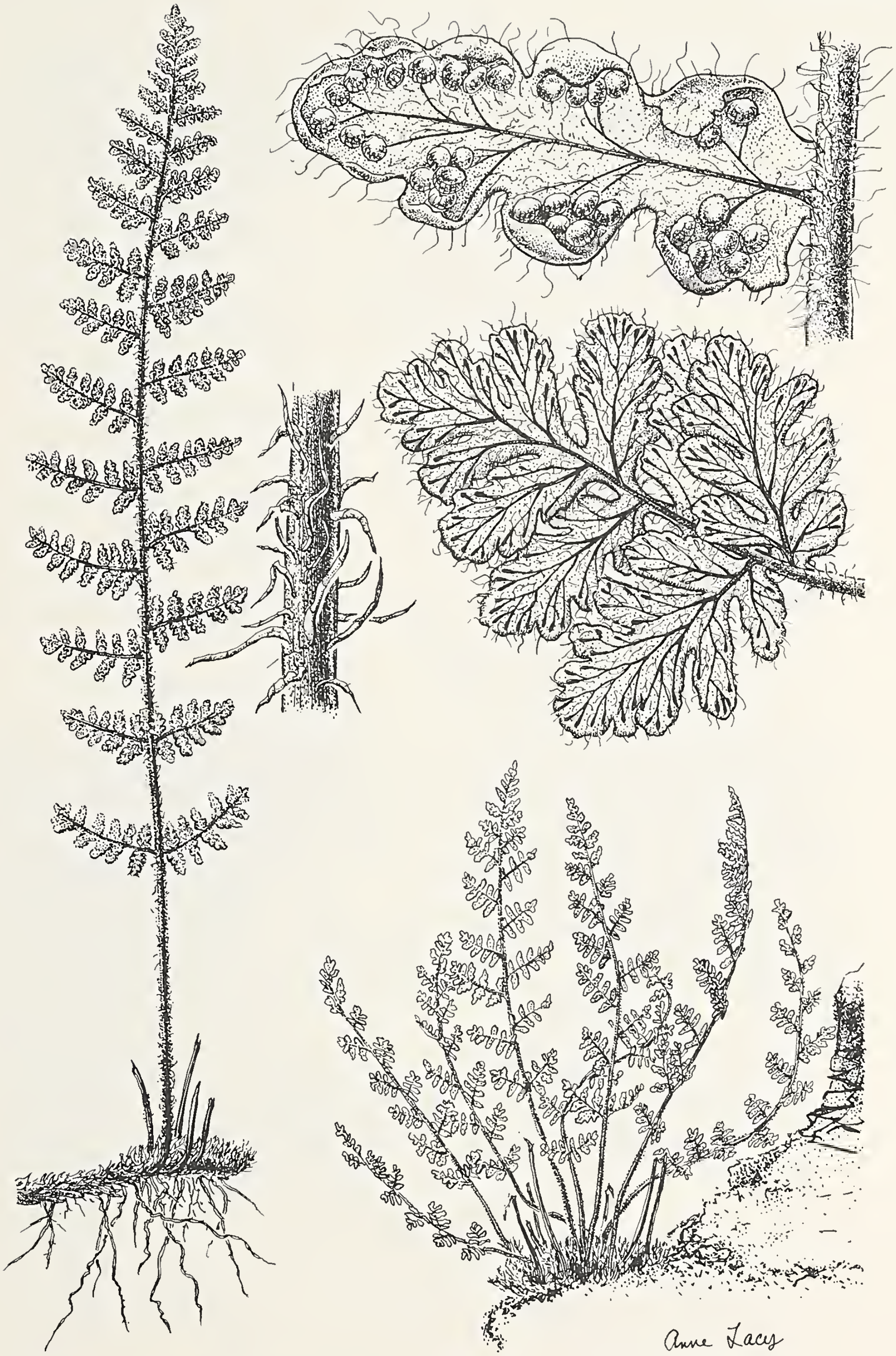
Filix fragilis, *C. mackayi*, *C. protrusa.*

NY, Vt, NH, Me, Mass, Ct, RI, NJ, Pa.

Moist, humus-rich crevices in cliffs, among rocks, mossy slopes, shady alluvial soil, sometimes grassy woods. Soil usually neutral to acid, pH usually 5-7.

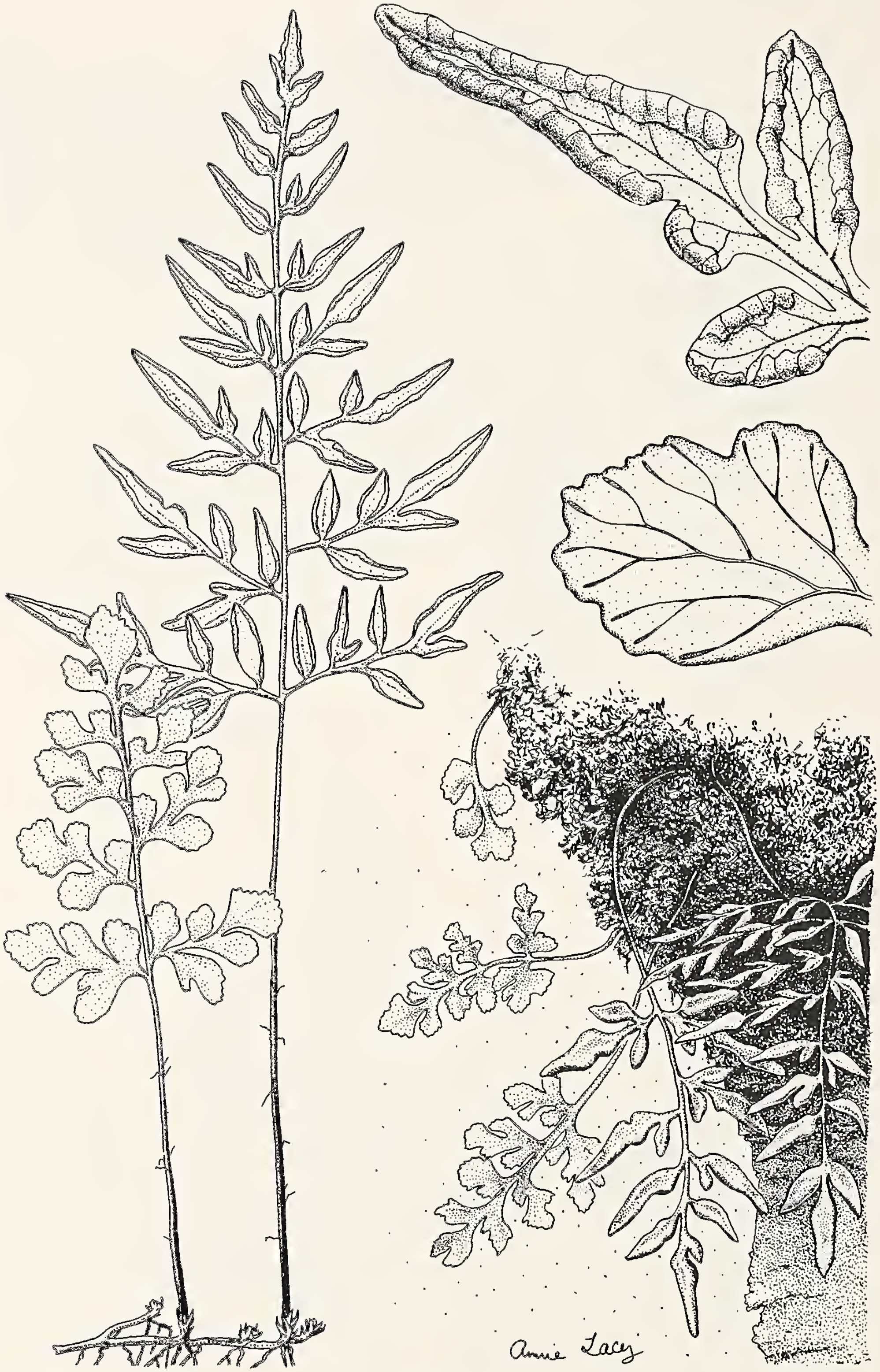
RHIZOMES with pale-brown scales. FRONDS not dimorphic, usually clustered, 10-25(-45) cm long, not evergreen. STIPE usually shorter than the blade, mostly glabrous, with a few scales at base, with 2 circular or oval bundles at base, these united near the blade or in the rachis. BLADES variable, usually ovate-lanceolate, (5-)10-20(-30) cm long, (3-)4-8(-12) cm wide, pinnate-pinnatifid to bipinnate or bipinnate-pinnatifid, rarely tripinnate; rachis glabrous, except for a few hairs at the base of the pinnae. PINNAE 9-15 pairs, opposite or nearly so, basal pinnae slightly shorter than the pair next above. PINNULES glabrous; margins denticulate. VEINS free, forked or not, mostly running to the teeth. SORI few, submarginal, circular, separate. INDUSIA laterally attached, hoodlike, often disappearing with age. SPORES bilateral, spiny.

Plate 20



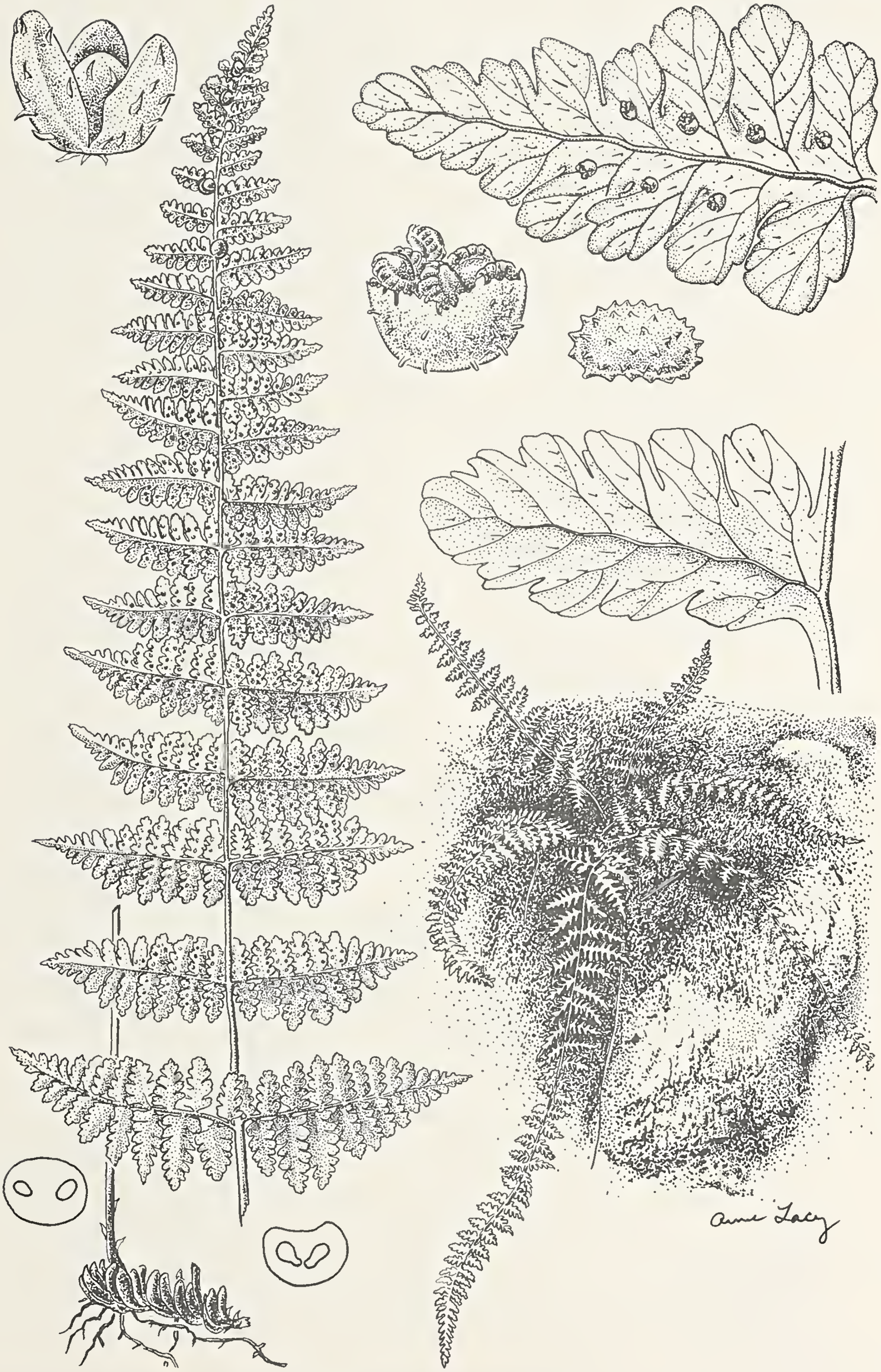
Cheilanthes lanosa HAIRY LIP FERN

Plate 21



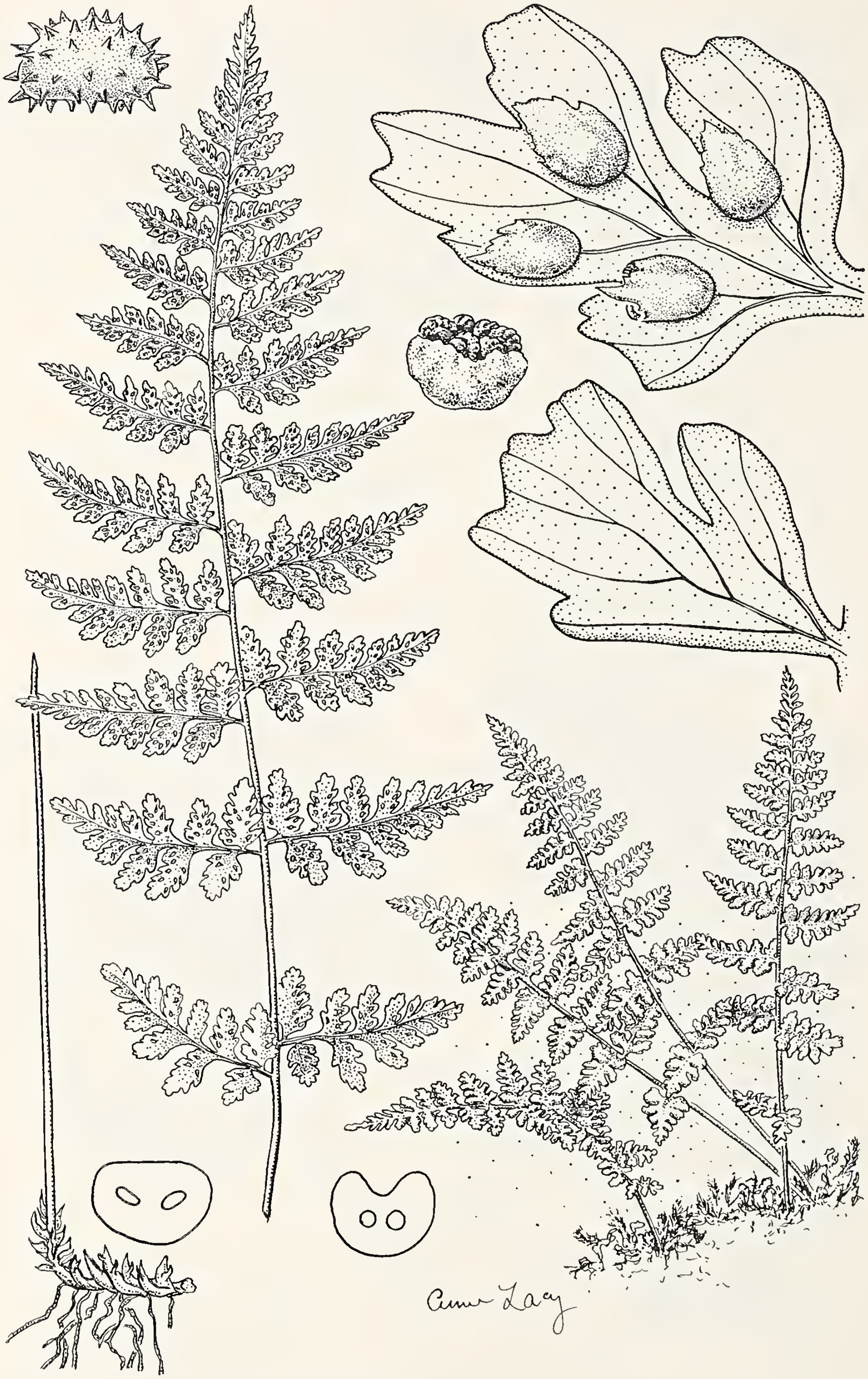
Cryptogramma stelleri SLENDER CLIFF BRAKE

Plate 22



Cystopteris bulbifera BULBLET BLADDER FERN

Plate 23



Cystopteris fragilis FRAGILE FERN

Resembles *Woodsia obtusa* which has a few scales on the rachis; *Cystopteris* does not. A highly variable species. *Cystopteris mackayi* and *C. protrusa* may be distinct species, and are so treated by some authors.

Dennstaedtia punctilobula (Michaux) Moore Plate 24

HAY-SCENTED FERN, BOULDER FERN

NY, Vt, NH, Me, Mass, Ct, RI, NJ, Pa.

Open woods, rocky places, cleared land, sometimes in wet places, thrives in open sun. Soil acid.

RHIZOMES slender, creeping, branching, 1-3 mm in diameter, hairy, scales absent or few. CROZIERS covered with silvery-white glandular hairs. FRONDS not dimorphic, coming separately from points on the rhizome, (25-)40-80(-120) cm long, not evergreen. STIPE shorter than the blade, 10-22 cm long, mostly 1.5-2.5 mm wide, chestnut-brown or nearly black below, greenish or yellowish above, glabrous or slightly hairy, with 1 horseshoe-shaped bundle that is not (or slightly) curved at the free ends (may be V-shaped in young fronds). BLADES lanceolate to ovate-lanceolate, (15-)20-40(-90) cm long, 10-25 cm wide, bipinnate to bipinnate-pinnatifid; rachis slender, hairy. PINNAE 17-30(40) pairs, opposite or alternate, lanceolate, largest 8-12 cm long, 2-3 cm wide, lower ones slightly shorter than middle ones. PINNULES 14-25 pairs per pinna, opposite or alternate, oblong to oblong-lanceolate, 1-2 cm long, with many small, whitish gland-tipped, hay-scented (especially when drying) hairs on upper and lower side; margins serrate. VEINS free, forked or not, not reaching the margin. SORI marginal, small, circular, at ends of the veins. INDUSIA cuplike, whitish. SPORES tetrahedral.

Dryopteris campyloptera (Kunze) Clarkson Plate 25

MOUNTAIN WOOD FERN, SPREADING SHIELD FERN

D. assimilis, D. austriaca var. *austriaca, D. dilatata, D. spinulosa* var. *americana, D. spinulosa* var. *dilatata, Thelypteris dilatata.*

NY, Vt, NH, Me, Mass, Pa.

Rocky, humus-rich woods, swamp margins, especially at higher elevations. Soil acid, pH mostly 5-6.

RHIZOMES stout, creeping to nearly erect, scaly, with old stipe bases. FRONDS not dimorphic, clustered, 45-100 cm long, not evergreen. STIPE shorter than blade, straw-colored, densely scaly, with 3-7(-9) circular bundles near base and upward. BLADES ovate-lanceolate, 30-60 cm long, 20-40 cm wide, bipinnate or bipinnate-pinnatifid to nearly tripinnate; rachis scaly. PINNAE opposite or alternate, lowest pair obliquely triangular, about as long as middle pinnae. PINNULES narrowly triangular or ovate-lanceolate, the lowest basal pinnule on the lower side of the lowest pinna longer than the other pinnules and three to five times as long and twice as wide as the opposing pinnule; margins with bristle-tipped teeth. VEINS free, forked, mostly not reaching the margin. SORI not marginal, circular, separate. INDUSIA reniform, often circular but with a sinus, glabrous or rarely glandular. SPORES bilateral.

Dryopteris clintoniana (D.C. Eaton) Dowell Plate 26

CLINTON'S SHIELD FERN, BROAD SWAMP FERN

D. cristata var. *clintoniana, Thelypteris c.*

NY, Vt, NH, Me, Mass, Ct, RI, NJ (?), Pa.

Swamps and wet woods. Soil acid, pH mostly 5-6.

RHIZOMES stout, short-creeping, scaly, with old stipe bases. FRONDS not dimorphic, borne in 1 or 2 rows along the rhizome, (15-)35-80(-120) cm long, usually evergreen. STIPE shorter than blade, straw-colored, scaly (at least at base), with 3-7(-9) circular bundles at base and upward. BLADES lanceolate or lanceolate-oblong, 30-60 cm long, 10-30 cm wide, pinnate-pinnatifid to bipinnate-pinnatifid; rachis with a few scales. PINNAE opposite or alternate, 10-15 pairs, oblong-lanceolate, short-stalked, lowest pair triangular and slightly shorter than middle pinnae; margins serrate or crenate, the teeth somewhat bristle-tipped. VEINS free, forked, mostly not reaching the margin. SORI not marginal, circular, separate. INDUSIA reniform, often circular but with a sinus, glabrous. SPORES bilateral.

Similar to *D. cristata* and sometimes treated as a variety of that species.

Hybrids between this species and other species of *Dryopteris* are known, notably with *D. cristata* and *D. goldiana.*

Dryopteris cristata (Linnaeus) A. Gray Plate 27

CRESTED SHIELD FERN, NARROW SWAMP FERN

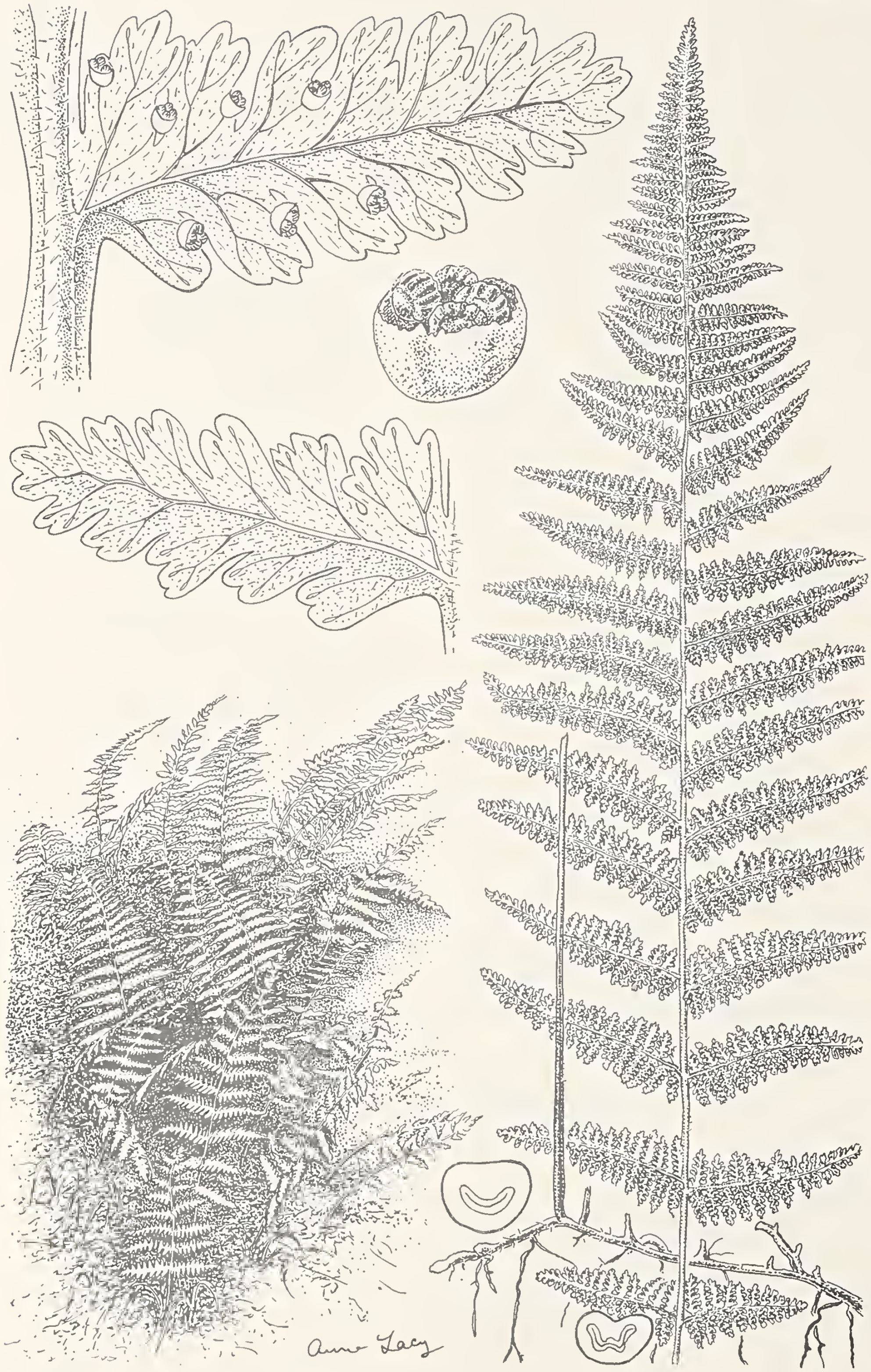
Thelypteris cristata

NY, Vt, NH, Me, Mass, Ct, RI, NJ, Pa.

Wet woods, marshes, swamps, bogs, meadows. Soil acid, pH mostly 5-6.

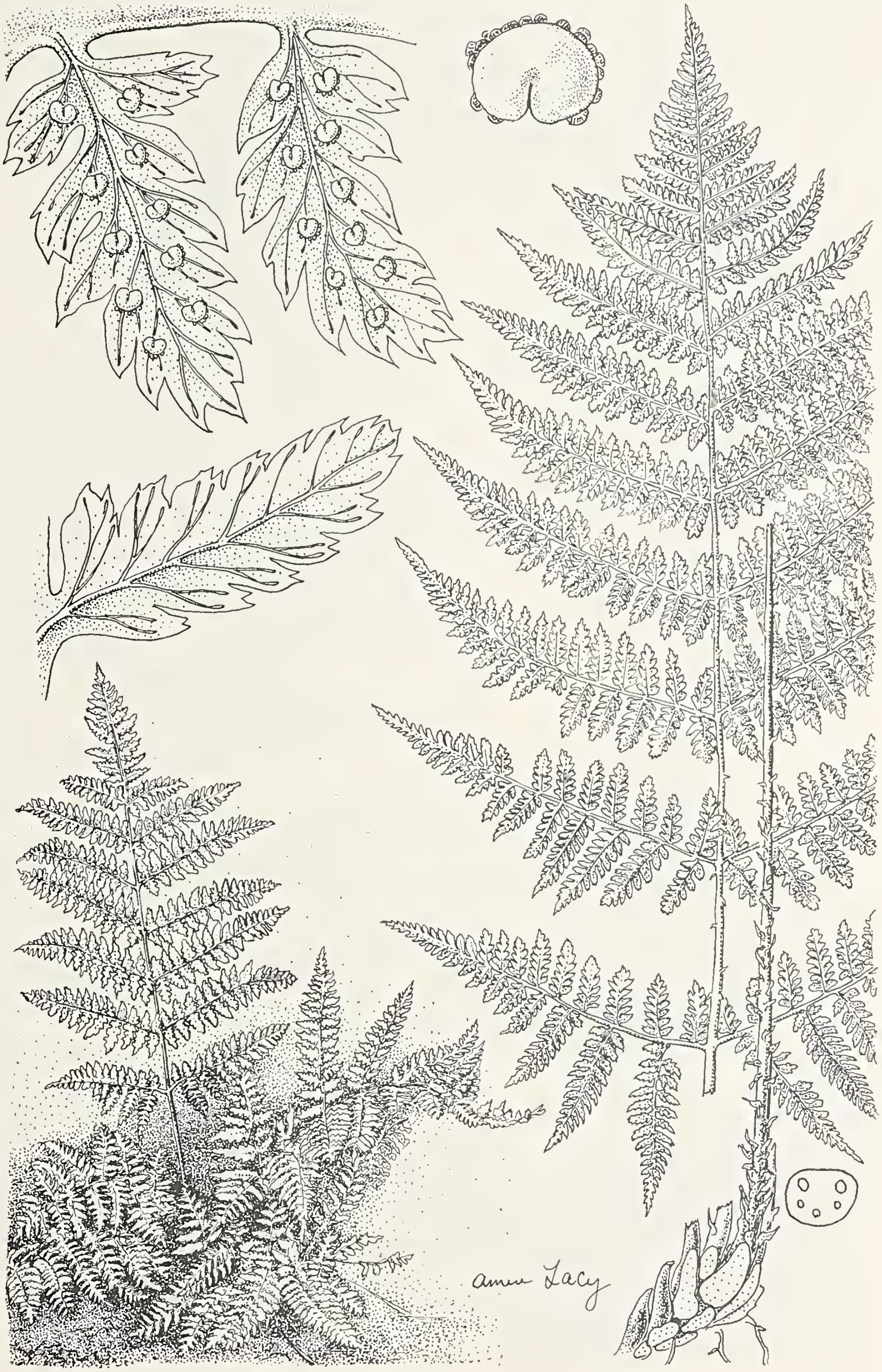
RHIZOMES stout, short-creeping, scaly, with old stipe bases. FRONDS not dimorphic, except that fertile fronds are usually taller than the sterile fronds and less evergreen, borne in 1 or 2 rows along the rhizome, (15-)35-80(-120) cm long, sterile fronds usually evergreen. STIPE usually shorter than blade, straw-

Plate 24



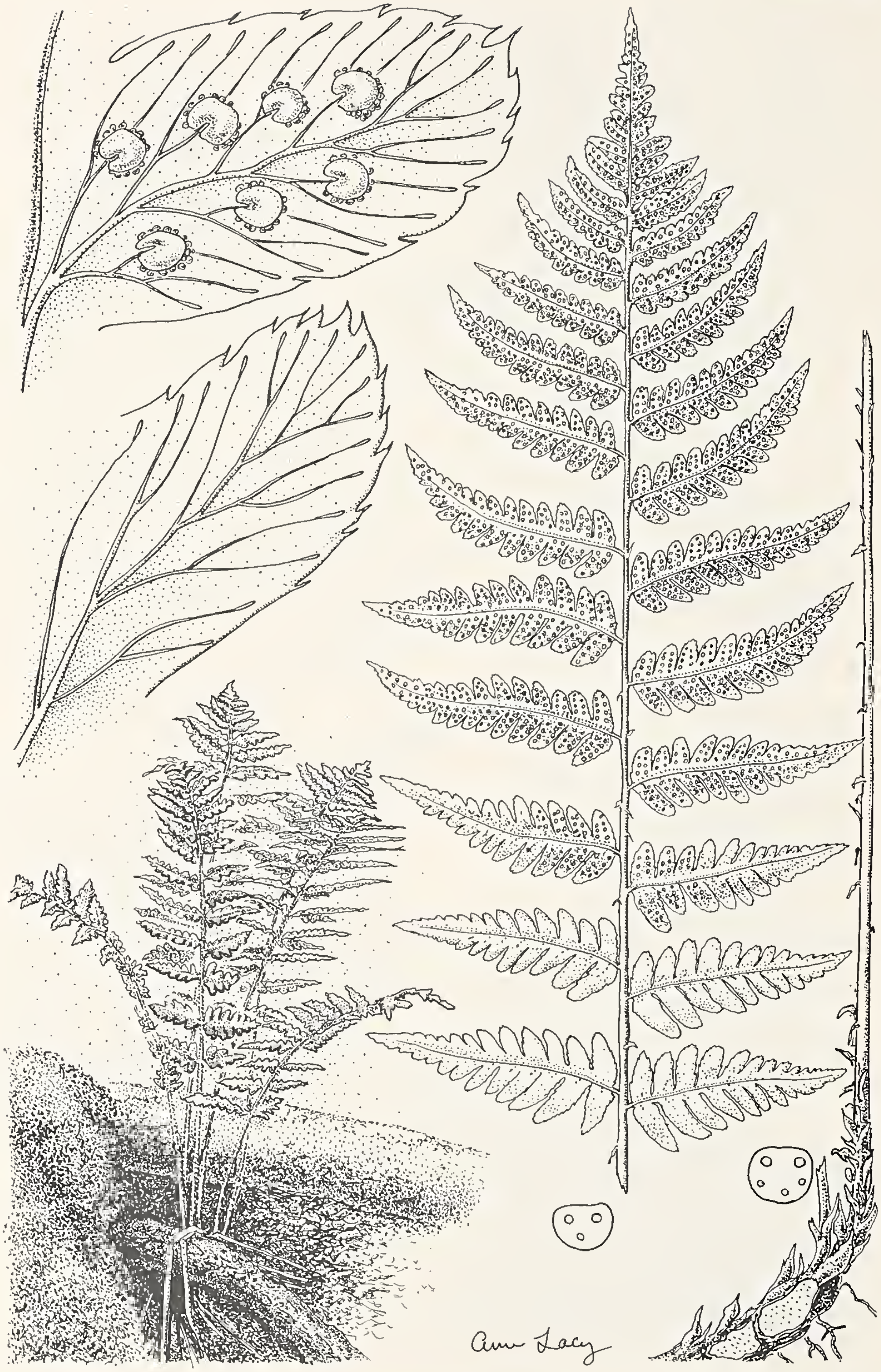
Dennstaedtia punctilobula HAY-SCENTED FERN

Plate 25



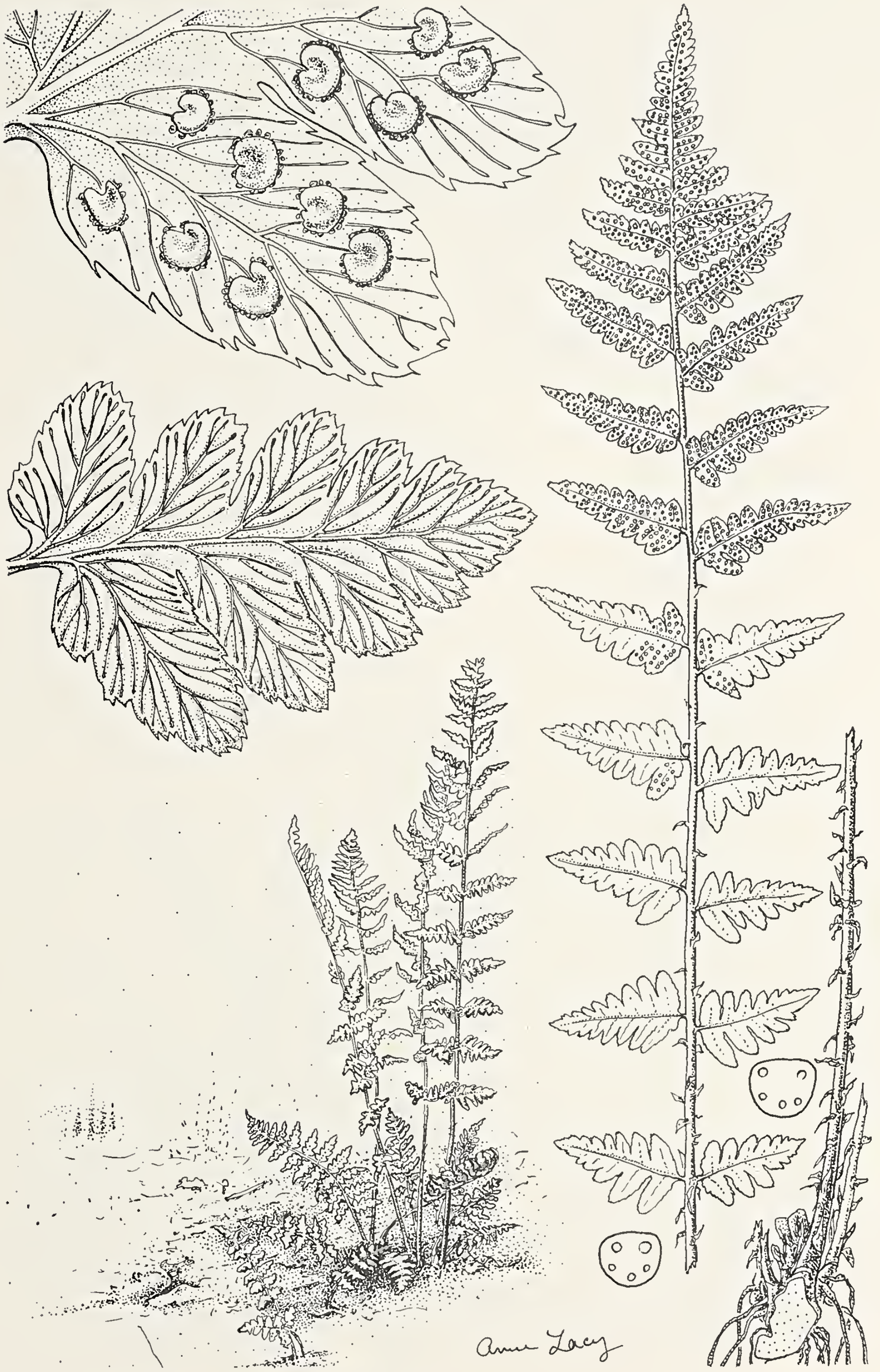
Dryopteris campyloptera MOUNTAIN WOOD FERN

Plate 26



Dryopteris clintoniana CLINTON'S SHIELD FERN

Plate 27



Dryopteris cristata CRESTED SHIELD FERN colored, scaly (at least at base), with 3-7(-9) circular bundles at base and upward. BLADES linear-lanceolate or narrowly lanceolate-oblong, 15-80 cm long, 6-18 cm wide, pinnate-pinnatifid to nearly bipinnate; rachis with a few scales. PINNAE opposite or alternate, 10-20 pairs, lanceolate short-stalked, lowest pair broadly triangular, about as wide as long, shorter than middle pinnae; margins serrate, the teeth somewhat bristle-tipped. VEINS, free, forked, mostly not reaching the margin. SORI not marginal, circular, separate. INDUSIA reniform, often circular but with a sinus, glabrous. SPORES bilateral.

Hybrids between this species and other species of *Dryopteris* are known, notably with *D. intermedia* (*D.* × *boottii*), *D. clintoniana*, *D. marginalis*, and *D. spinulosa*.

Dryopteris fragrans (Linnaeus) Schott Plate 28

FRAGRANT SHIELD FERN, FRAGRANT CLIFF FERN

Thelypteris fragrans

NY (rare), Vt (rare), NH (rare), Me (rare).

Dry or moist shaded cliffs and slopes. Soil acid to neutral, pH mostly 5-7.

RHIZOMES stout, erect, scaly, with old stipe bases and old persistent fronds. FRONDS not dimorphic, clustered, 7-30(-45) cm long, evergreen. STIPE much shorter than blade, straw-colored, densely scaly, with 3-7(-9) circular bundles at base and upward. BLADES linear-lanceolate, 8-25(-35) cm long, 1-6 cm wide, pinnate-pinnatifid to bipinnate, rarely bipinnate-pinnatifid; rachis with few to many scales. PINNAE opposite or alternate, 15-40 crowded pairs, oblong, sessile or short-stalked, with aromatic glandular hairs on upper and lower sides, lowest pair much shorter than middle pinnae; margins crenate but not bristle-tipped. VEINS obscure, free, usually not forked, 2 or 3 pairs per segment, mostly not reaching the margin. SORI not marginal, circular, separate but large (1-2 mm) and close together, chocolate-brown. INDUSIA large, reniform, circular but each with a narrow sinus, margin glandular. SPORES bilateral.

Dryopteris goldiana (W.J. Hooker) A. Gray Plate 29

GOLDIE'S SHIELD FERN, GIANT WOOD FERN

NY, Vt, NH, Me, Mass, Ct, NJ, Pa.

Rich, moist woods and shaded stream banks. Soil about neutral.

RHIZOMES stout, short-creeping, scaly, with old stipe bases. FRONDS not dimorphic, clustered, 50-130 cm long, semi-evergreen. STIPE shorter than blade, straw-colored, densely scaly, with 3-7(-9) circular bundles at base and upward. BLADES triangular to ovate or broad-lanceolate, 25-65 cm long, 20-40(-50) cm wide, pinnate-pinnatifid to bipinnate-pinnatifid golden-green; rachis scaly. PINNAE mostly opposite (at least below), alternate above, 10-20(-35) pairs, lanceolate with short stalks, the lowest pair usually slightly shorter than middle pinnae; margins serrate, teeth with a very short bristle at apex. VEINS free, mostly forked, scaly, most not reaching the margin. SORI not marginal, circular, separate or confluent, golden brown. INDUSIA reniform, circular but with a small sinus. SPORES bilateral.

Hybrids between this species and other species of *Dryopteris* are known, notably with *D. clintoniana* and *D. marginalis*.

Dryopteris celsa (Palmer) Small, LOG FERN, apparently is closely related to *D. goldiana*, although it more closely resembles *D. clintoniana*. It is now generally recognized as a distinct species, having been formerly treated as a subspecies, or a variety, or a form of *D. goldiana*. It is rare and local in our area, being reported from Pennsylvania, New Jersey, and New York. It differs from *D. goldiana* in that the blade color is a uniform, dark green (rather than dark and light areas) and the blade tapers gradually to the tip (rather than abruptly to a short acuminate tip). It differs from *D. clintoniana* in that the lowest pinnae are narrower at base than at middle (rather than wider at base).

Dryopteris intermedia (Muhlenberg) A. Gray Plate 30

FANCY FERN, COMMON WOOD FERN

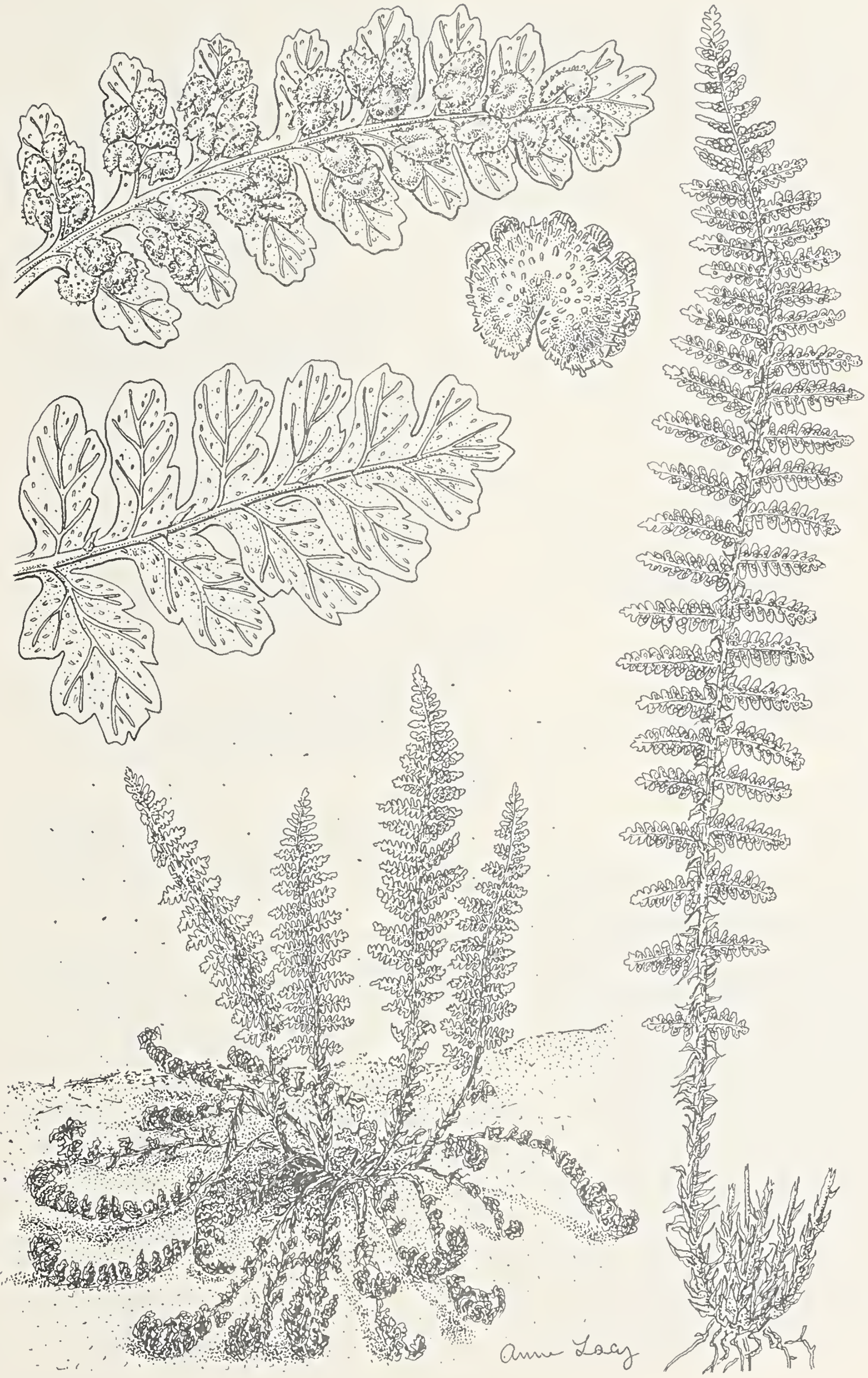
D. austriaca var. *intermedia*, *D. spinulosa* var. *i.*

NY, Vt, NH, Me, Mass, Ct, RI, NJ, Pa.

Moist woods, rocky slopes, hummocks in swamps. Soil acid to neutral, pH usually 5-7.

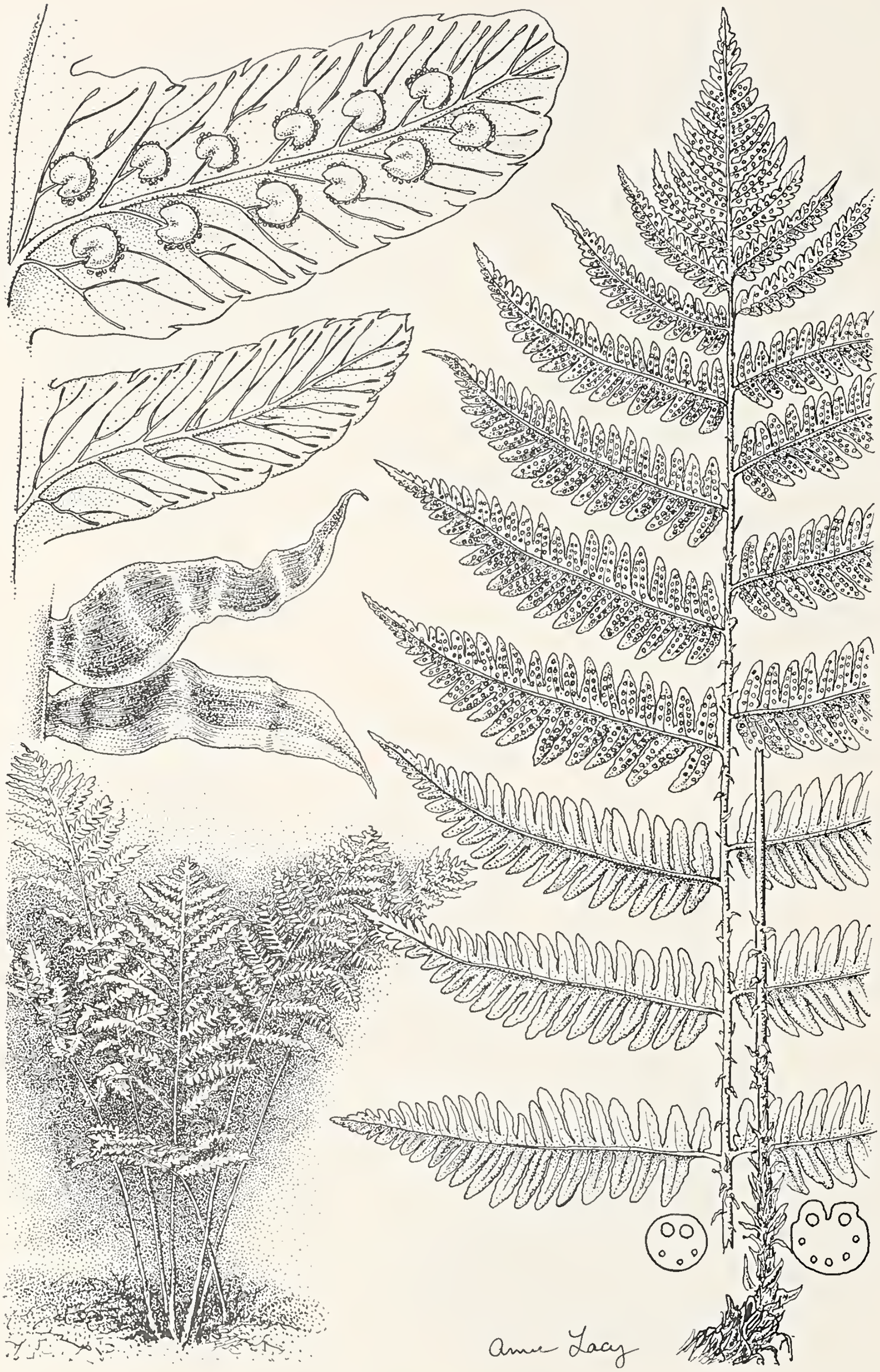
RHIZOMES stout, nearly erect, scaly, with old stipe bases. FRONDS not dimorphic, clustered, 20-75 cm long, evergreen. STIPE shorter than blade, straw-colored, with hairs and scales, with 3-7(-9) circular bundles at base and upward. BLADES oblong-lanceolate, 25-50 cm long, 13-25(-30) cm wide, bipinnate-pinnatifid to tripinnate; rachis with glandular hairs (except on overwintered evergreen blades). PINNAE opposite or nearly so, 10-20(-30) pairs, lanceolate, lowest pair obliquely ovate and about same length as middle pinnae, midveins with hairs. PINNULES oblong-lanceolate, second from the rachis on the lowest pinna usually the longest, with hairs; margins with bristle-tipped teeth. VEINS free, forked, mostly not reaching the margin. SORI not marginal, circular, separate. INDUSIA reniform, often circular, but with a sinus, with glandualr hairs which may disappear with age. SPORES bilateral.

Plate 28

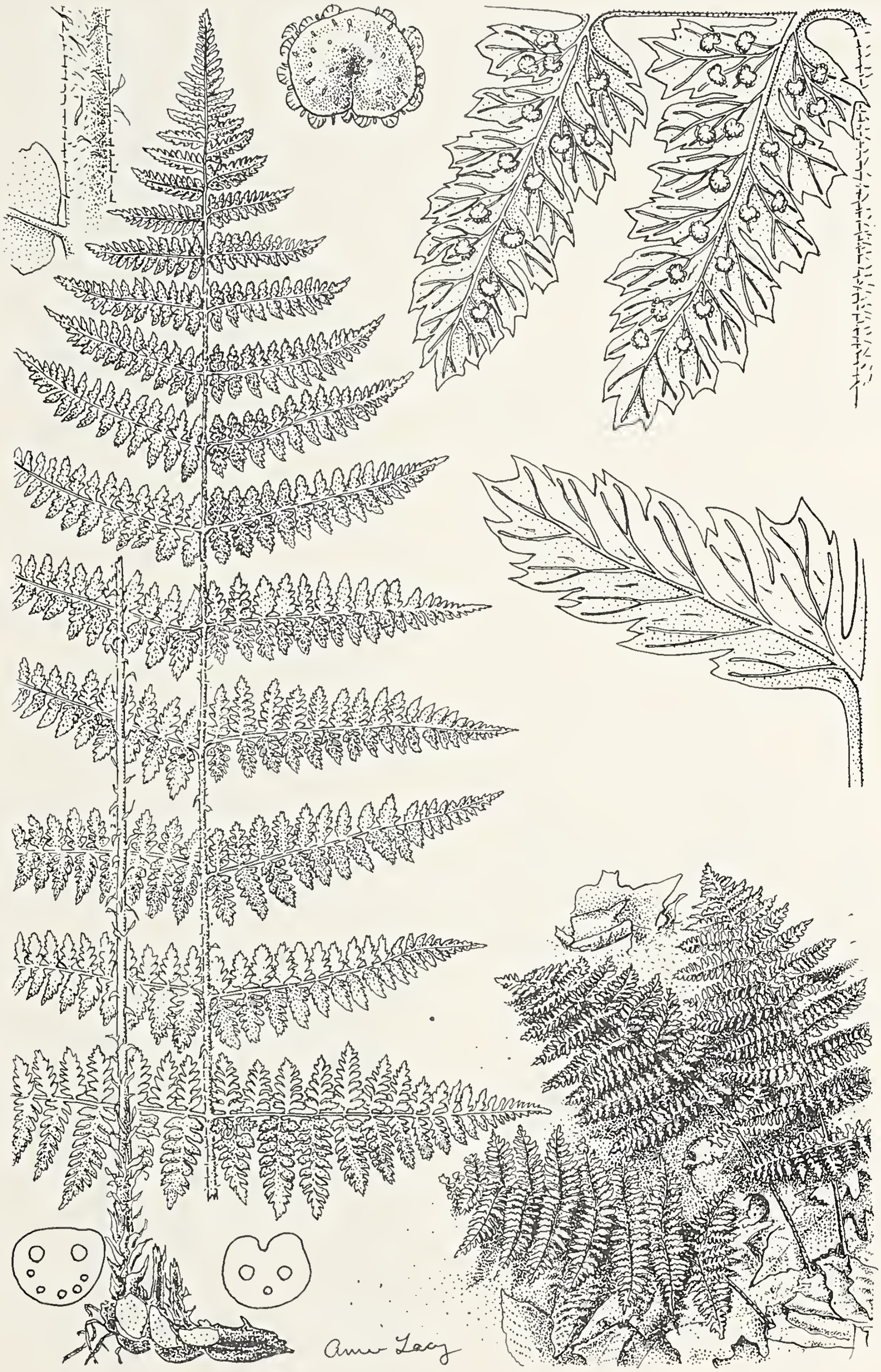


Dryopteris fragrans FRAGRANT SHIELD FERN

Plate 29



Dryopteris goldiana GOLDIE'S SHIELD FERN



Dryopteris intermedia FANCY FERN

This is our only species of *Dryopteris* with hairs on the stipe and rachis, although *D. marginalis* may have some scales that are slender and hair-like on the underside of the rachis. A common fertile hybrid *(D. cristata × intermedia)* also has the glandular hairs. It may be called *D. × boottii*. *D. intermedia* also hybridizes with other species of *Dryopteris*, notably with *D. spinulosa*.

Dryopteris marginalis (Linnaeus) A. Gray Plate 31

MARGINAL SHIELD FERN, EVERGREEN WOOD FERN

NY, Vt, NH, Me, Mass, Ct, RI, NJ, Pa.

Rocky woods, shaded ledges, talus slopes, clay banks, sometimes hummocks in swamps. Soil variable, often sterile, mostly acid but also neutral or slightly alkaline.

RHIZOMES stout, erect, scaly, with old stipe bases. FRONDS not dimorphic, clustered, (15-)35-100 cm or more long, evergreen. STIPE shorter than blade, straw-colored, densely scaly, with 3-7(-9) circular bundles at base and upward. BLADE ovate-oblong to lanceolate, 25-50(-75) cm long, (5-)10-25 cm wide, pinnate-pinnatifid to bipinnate, rarely bipinnate-pinnatifid; rachis with scales (some may be slender and hair-like) on the underside. PINNAE opposite or alternate, 15-20 pairs, oblong to lanceolate, short-stalked, the lowest pair usually slightly shorter than middle pinnae. PINNULES oblong, obtuse, glabrous; margins with obscure teeth which are not bristle-tipped. VEINS free, forked, mostly not reaching the margin. SORI near the pinnule margin, circular, separate. INDUSIA reniform, often circular but each with a sinus. SPORES bilateral.

Fruiting fronds easily distinguished from our other species of *Dryopteris* by the submarginal position of the sori. Hybrids between this species and other species of *Dryopteris* are known, notably with *D. cristata*, *D. goldiana*, and *D. spinulosa*.

Dryopteris filix-mas (Linnaeus) Schott, MALE FERN, rare in Vermont and Maine, is similar to *D. marginalis* but its sori are not marginal and it usually has more than 20 pairs of pinnae, the lowest pair being much shorter than the middle pinnae.

Dryopteris spinulosa (O. F. Mueller) Watt Plate 32

SPINULOSE SHIELD FERN, EVERGREEN WOOD FERN

D. austriaca var. *spinulosa*

NY, Vt, NH, Me, Mass, Ct, RI, NJ, Pa.

Wet woods, swamps, moist rocky slopes. Soil usually acid, pH mostly 5-6.

RHIZOMES stout, creeping, scaly, with old stipe bases. FRONDS not dimorphic, clustered, 25-65(-100) cm long, evergreen or nearly so, especially the sterile fronds. STIPE shorter than blade, straw-colored, scaly, with 3-7(-9) circular bundles at base and upward. BLADES lanceolate, (10-)20-45(-60) cm long, (6-)15-25 cm wide, bipinnate or bipinnate-pinnatifid to nearly tripinnate; rachis with a few scales. PINNAE opposite or alternate, ascending, 10-20(-30) pairs, lowest pair obliquely triangular and about same length as middle pinnae. PINNULES lanceolate, acute at apex, the one closest to the rachis on the lower side of the lowest pinna longer than the other pinnules and two to three times as long as the opposing pinnule, segments oblong, obtuse, glabrous; margins with bristle-tipped teeth. VEINS free, forked, mostly not reaching the margin. SORI not marginal, circular, separate. INDUSIA reniform, often circular but with a sinus, glabrous. SPORES bilateral.

Hybrids between this species and other species of *Dryopteris* are known, notably with *D. cristata*, *D. intermedia*, and *D. marginalis*.

Gymnocarpium dryopteris (Linnaeus) Newmann Plate 33

OAK FERN

Phegopteris dryopteris, *Thelypteris dryopteris*, *Dryopteris disjuncta*

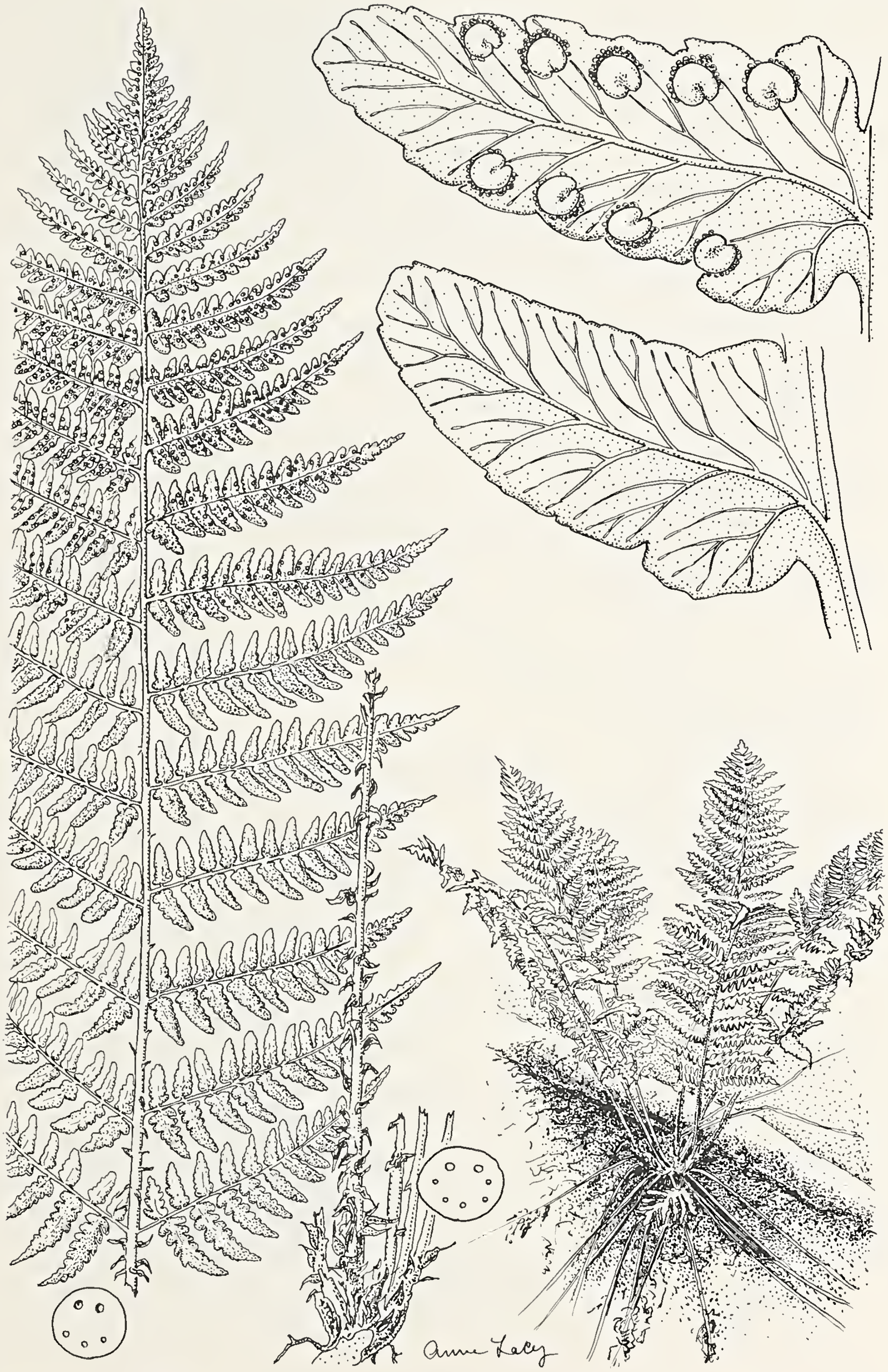
NY, Vt, NH, Me, Mass, Ct, RI, NJ, Pa.

Moist woods, swamp margins, often under conifers. Soil usually acid, pH mostly 5-6.

RHIZOMES branched, blackish, 1-1.5 mm in diameter, scaly. CROZIERS small, green, 3 in a group. FRONDS not dimorphic, coming from separate points on the rhizome, (8-)13-45(-60) cm long, not evergreen. STIPE slender, longer than the blade, glabrous, with a few scales at base, with 2 circular or oval bundles at base and upward. BLADES triangular to triangular-pentagonal (ternate, each third triangular), 7-20 cm long, 10-25 cm wide, bipinnate-pinnatifid to tripinnate-pinnatifid, borne at a right-angle to the stipe and thus horizontal; rachis delicate, green, glabrous. PINNAE opposite, 5 or more pairs, lowest pair longest and divided into pinnules; only the lowest pair of pinnae with stalks. PINNULES oblong, pinnatifid, opposite, glabrous; margins entire or crenate. VEINS free, mostly not forked, reaching the margin, 2-6 pairs per segment. SORI near the margin, circular, separate, sometimes becoming contiguous at maturity. INDUSIA absent. SPORES bilateral.

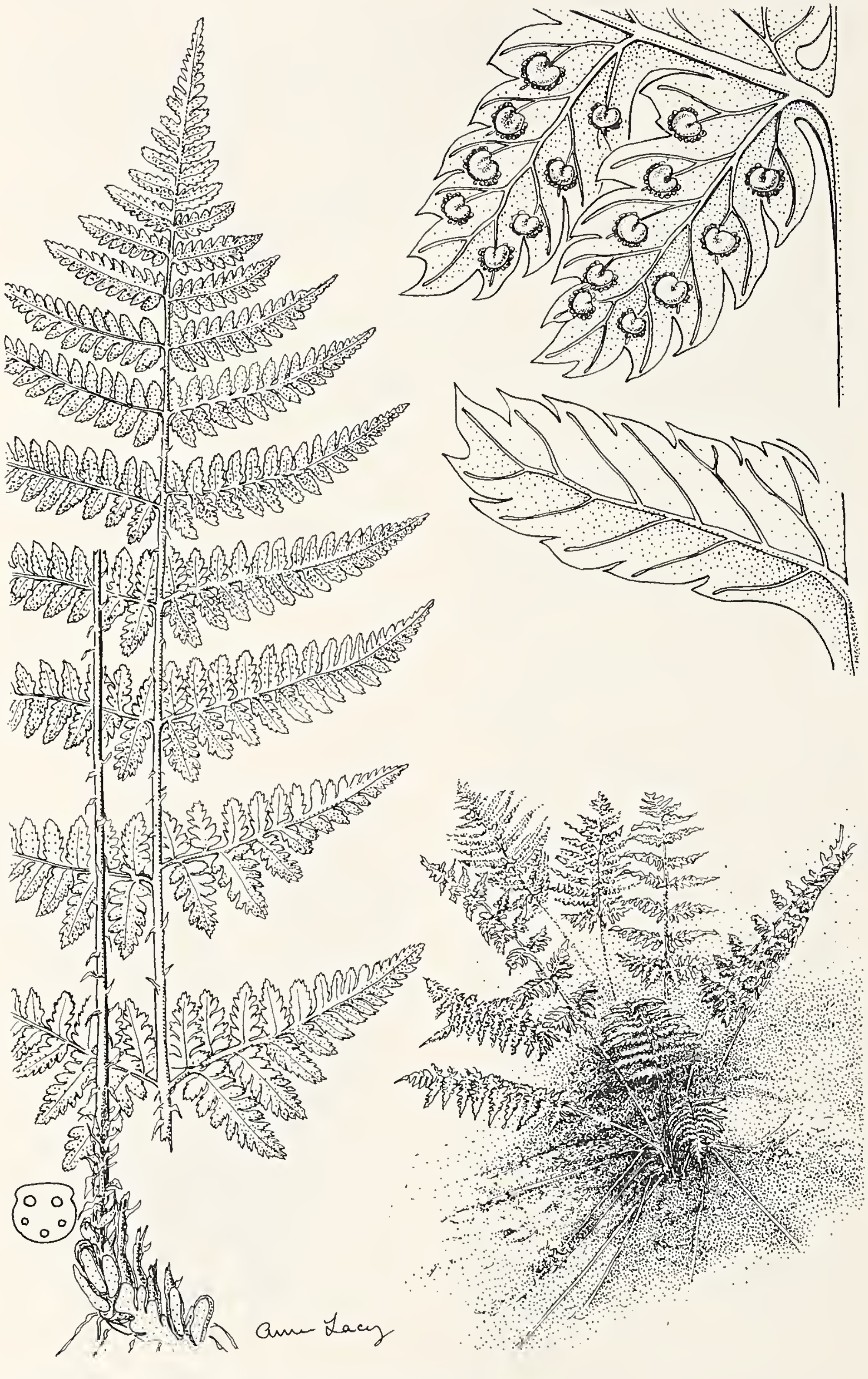
Gymnocarpium robertianum does not occur in our area, except for a single disjunct station in Pennsylvania. It differs from *G. dryopteris* in having the lowest two pairs of pinnae with stalks and the blade with many short glandular hairs.

Plate 31



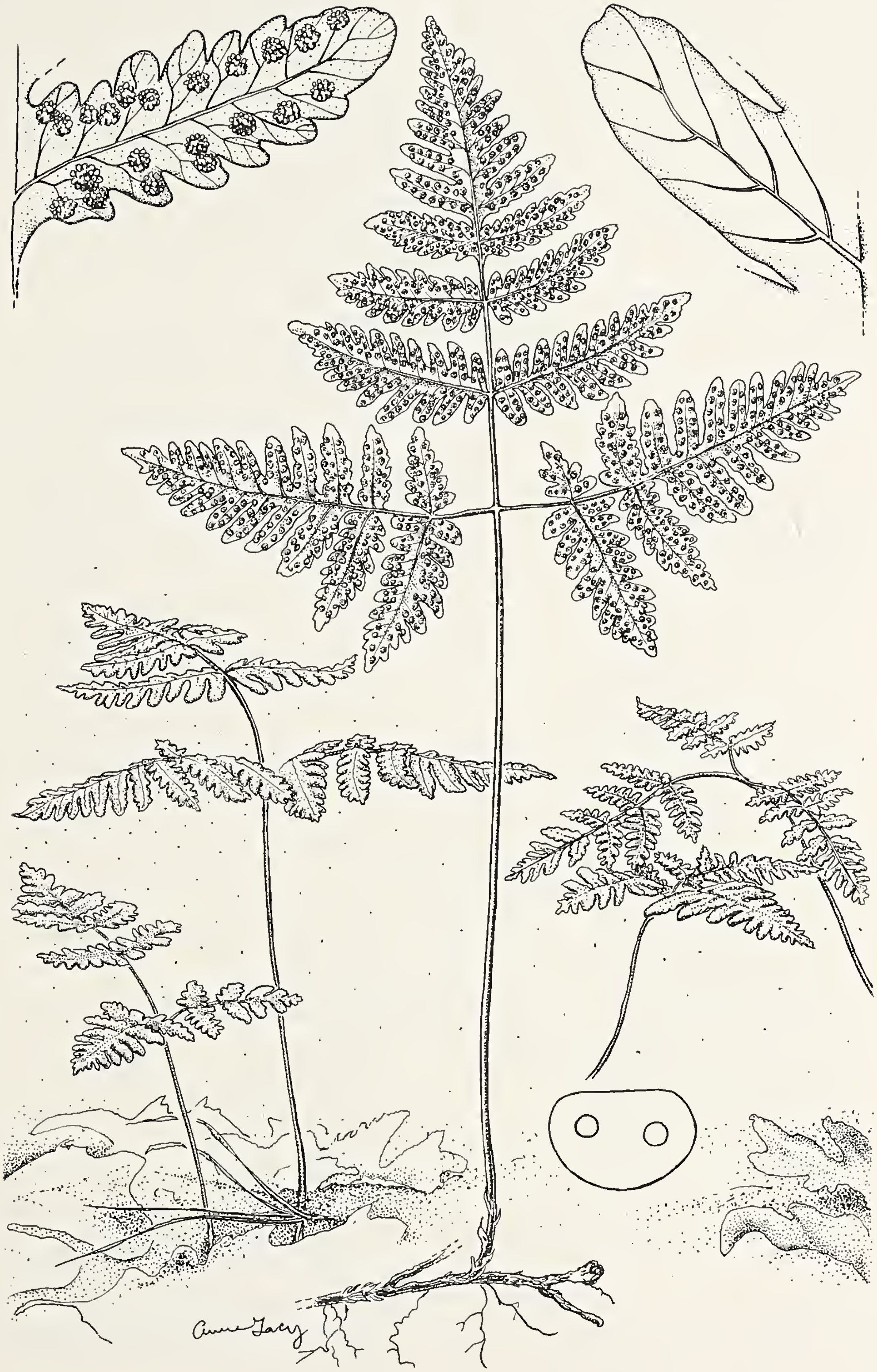
Dryopteris marginalis MARGINAL SHIELD FERN

Plate 32



Dryopteris spinulosa SPINULOSE SHIELD FERN

Plate 33



Gymnocarpium dryopteris OAK FERN

Lorinseria areolata (Linnaeus) Presl Plate 34

NETTED CHAIN FERN, NARROW-LEAVED CHAIN FERN

Woodwardia areolata

NY (southeast), NH (rare), Me (rare, no voucher), Mass, Ct., RI, NJ, Pa.

Swamps, wet woods, bog margins, shallow water, can grow in full sun. Soil very acid.

RHIZOMES slender, creeping, 3-3.5(-4) mm in diameter, scaly. CROZIERS appear late spring, densely covered with light-brown scales. FRONDS dimorphic, borne singly from points on the rhizome, but may be in mass because of intricate growth of rhizomes, 30-80 cm long, fertile fronds usually longer than sterile fronds, not evergreen. STIPE about same length as blade, 1-5 mm wide, with a few scales, sterile straw-colored or greenish, fertile brown-purple to blackish, with 2 circular or linear curved bundles. STERILE BLADES triangular-ovate, 15-40 cm long, (6-)10-17(-20) cm wide, mostly deeply pinnatifid but often pinnate at base; rachis with a few scales. STERILE PINNAE (or segments) 7-10 pairs alternate, linear-lanceolate to oblong-lanceolate, lower and middle pinnae about same length, glabrous, with a few scales; margins entire to serrulate. VEINS reticulate, only the outer ones free and reaching the margin. FERTILE BLADES essentially pinnate with narrowly linear pinnae, stipe as long or longer than the blade. SORI not marginal, linear or linear-oblong, 4-8 mm long, not confluent (at least when young). INDUSIA laterally attached, inconspicuous when young, opening toward the midvein. SPORES bilateral.

Sterile fronds are similar to those of *Onoclea sensibilis*, but they can be distinguished by their alternate pinnae and serrulate margins.

Lygodium palmatum (Bernhardi) Swartz Plate 35

CLIMBING FERN, HARTFORD FERN

NY (rare), Vt (rare), NH (rare), Mass (rare), Ct (rare), RI (rare), NJ, Pa.

Moist woods, wet slopes, boggy places. Can grow on sandy soil but requires water around the roots. Soil very acid, pH 4-5.

RHIZOMES branched, black, about 1 mm in diameter, without scales, with a few septate hairs. FRONDS dimorphic, divided into sterile and fertile parts, usually 40-100 cm long, climbing. STIPE shorter than the blade portion, about 1 mm in diameter, with 1 bundle. STERILE PINNAE alternate, each divided into two stalked pinnules. STERILE PINNULES palmately lobed, 2-4 cm long, 2-7 cm wide, glabrous, on stalks 1-2 cm long; margins entire. VEINS free, forked several times. FERTILE PINNAE above the sterile pinnae, several times dichotomously branched, the ultimate segments 3-5 mm long, 1-2 mm wide. SORI in a double row on the segments. INDUSIA only the pinnule margins modified to laterally attached, overlapping scales. SPORES tetrahedral.

This is our only fern with the twining habit.

Marsilea quadrifolia Linnaeus Plate 36

WATER CLOVER, PEPPERWORT

NY (rare), Me (rare), Mass, Ct, NJ, Pa. Introduced from Europe.

Shallow water, rooted in mud. Soil mostly neutral.

RHIZOMES elongate, slightly branched, 0.5-0.8 mm in diameter, glabrous or with hairs, without scales. FRONDS to 40 cm long, depending on water depth. STIPE much longer than blade. BLADES floating, submerged or emergent, palmate, with 4 pinnae. PINNAE obovate or triangular, 0.8-2.7 cm long and wide, nearly glabrous; margins entire or nearly so. VEINS forking with many cross-veins. SPOROCARPS on stalks attached to the stipe near its base, usually 2 per stalk, 4-5 mm long, 3-3.5 mm wide, with yellowish hairs when young, glabrous or nearly so when mature. SORI with several sporangia in two rows within each sporocarp. INDUSIA delicate. SPORES tetrahedral, of two sizes, each sporangium with many microspores or with one macrospore.

This plant may become weedy, even in pools that become dry for periods of time, since the hard-walled sporocarps persist as propagules.

Matteuccia struthiopteris (Linnaeus) Todaro Plate 37

OSTRICH FERN

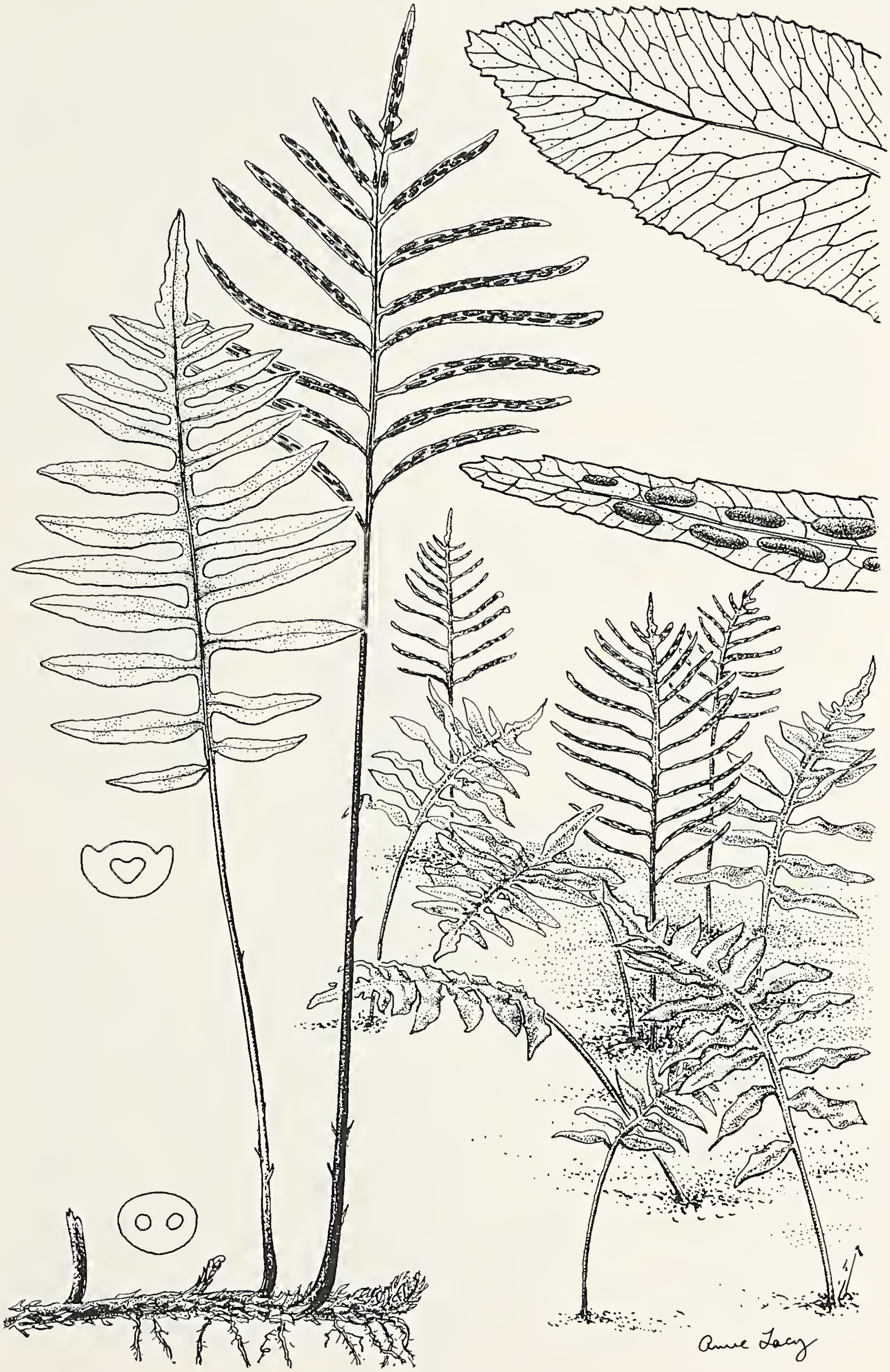
M. pensylvanica, Pteretis nodulosa, Pteretis pensylvanica

NY, Vt, NH, Me, Mass, Ct, RI (rare), NJ, Pa.

Rich, alluvial soil along streams, moist woods. Soil neutral or nearly so.

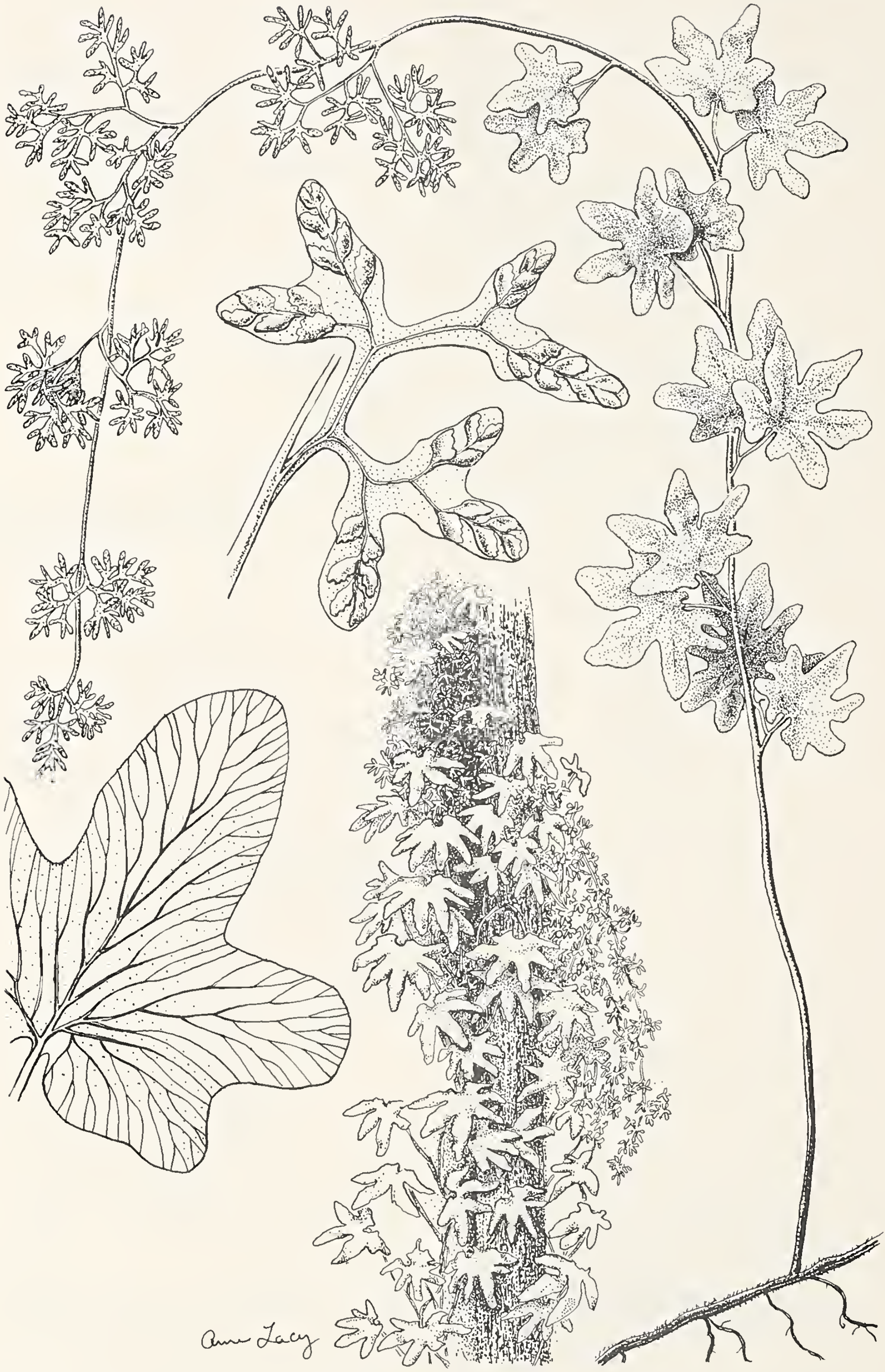
RHIZOMES stout, erect, branched, scaly. CROZIERS 2-4 cm wide, green with deciduous light brown scales. FRONDS dimorphic, several in a cluster, not evergreen. Sterile fronds 45-100 (-300) cm long. Fertile fronds shorter than sterile, 30-70 (-100) cm long, plumose, remaining upright in winter. STIPE of sterile frond green, much shorter than blade, 6-40 cm long, 2-6 mm wide, each deeply grooved on one side, with 2 linear bundles at base which may be united upward. STIPE of fertile frond similar but about same length as blade. STERILE BLADES elliptic, 50-100 cm long, (12-)15-35(-60) cm wide, pinnate-pinnatifid; rachis with whitish hairs. STERILE PINNAE 20 or

Plate 34



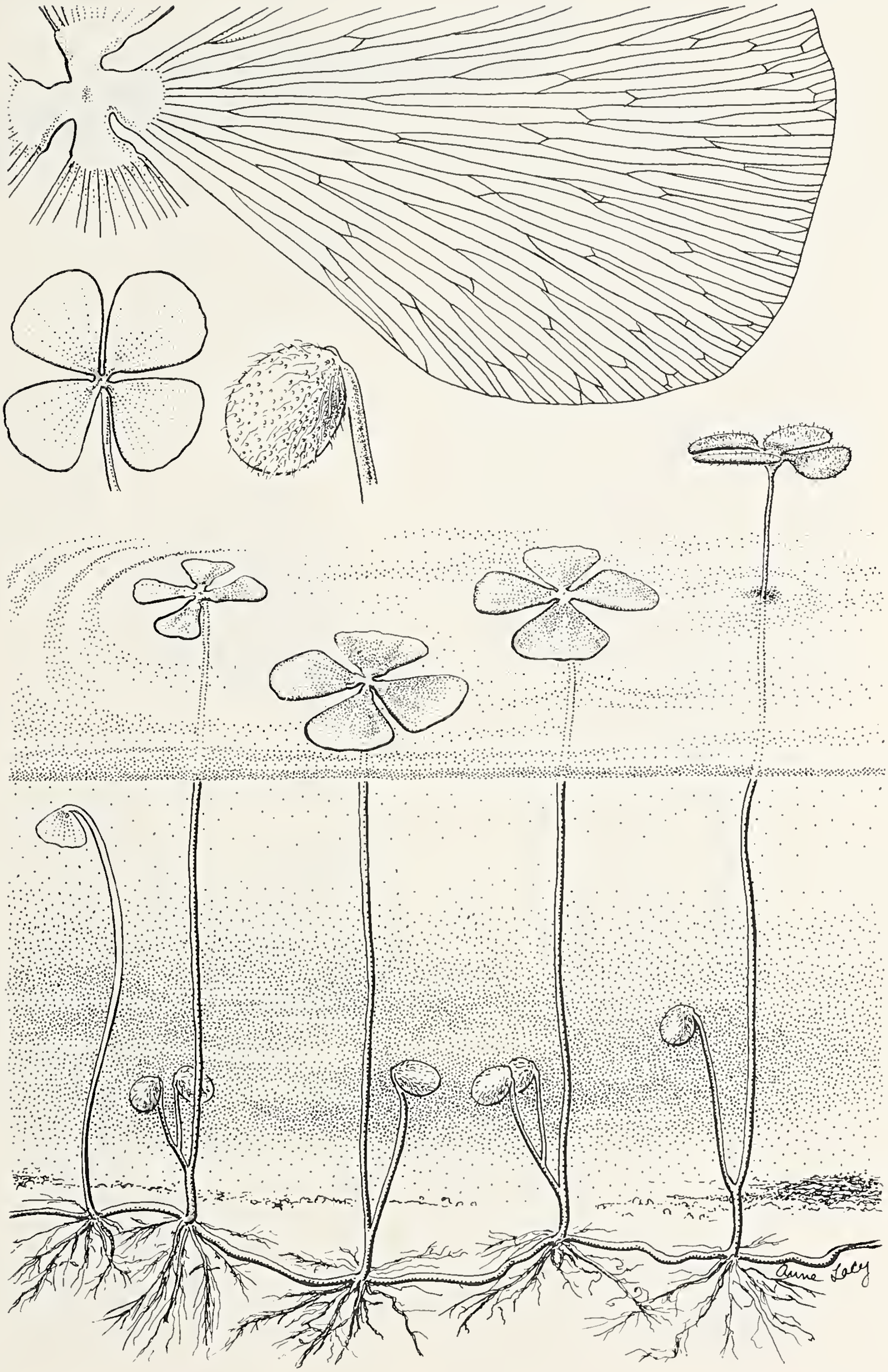
Lorinseria areolata NETTED CHAIN FERN

Plate 35



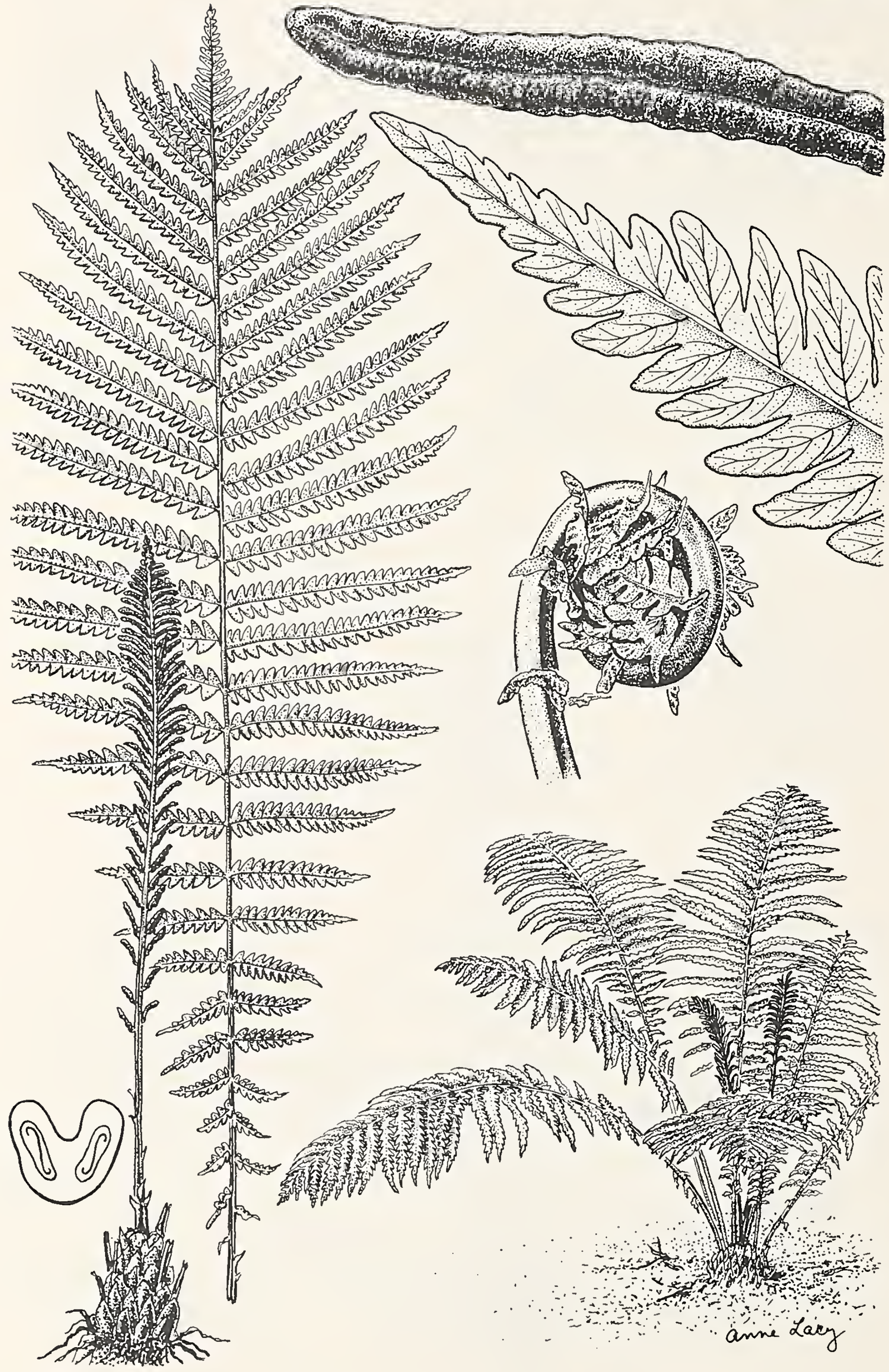
Lygodium palmatum CLIMBING FERN

Plate 36



Marsilea quadrifolia WATER CLOVER

Plate 37



Matteuccia struthiopteris OSTRICH FERN more pairs, alternate, long-acuminate, sessile, lowest pinnae much shorter than middle pinnae; margins finely denticulate to nearly entire. VEINS of sterile pinnae free, not forked, reaching the margin, 7-9 pairs per segment. FERTILE BLADES elliptic, 15-30 cm long, 5-8 cm wide, pinnate, dark green to blackish, drying to brown. SORI several on a segment, inrolled in the margins. INDUSIA hoodlike, lacerate to raylike. SPORES bilateral.

Onoclea sensibilis Linnaeus Plate 38

SENSITIVE FERN, BEAD FERN

NY, Vt, NH, Me, Mass, CT, RI, NJ, Pa.

Swamps, marshes, moist meadows. Tolerates full sun. Soil neutral to acid, pH often 5-6.

RHIZOMES slender, branched, mostly 3-5 mm in diameter, with a few scales. FRONDS dimorphic, borne singly from points on the rhizome. Sterile fronds mostly 50-130 cm long, not evergreen, turning brown during late summer and early fall, even before frost. Fertile fronds shorter than sterile fronds, not evergreen but persistent and erect during winter, sometimes for 2 or 3 years. STIPE longer than blade, 15-65 cm long, 1-4 mm wide, buff to brown, glabrous, with a few scattered scales at base and sometimes hemispherical in cross section upward, shallowly grooved, each with 2 linear, slightly curved bundles at base which are united upward. STERILE BLADES broad-triangular, (10-)15-35(-40) cm long, (10-)20-40 cm wide, pinnatifid above to pinnate or pinnate-pinnatifid below; rachis winged, especially upward. STERILE PINNAE 2-16 pairs, usually opposite or nearly so, oblong-lanceolate, upper ones sessile, lower ones with stalks, lower pinnae longer than middle pinnae, glabrous on upper side, with a few septate, white hairs on underside; margins entire, sinuate or pinnatifid. VEINS reticulate, outer ones free and reaching the margin. FERTILE BLADES lanceolate to ovate or elliptic, bipinnate, dark brown with buff rachises. SORI circular to oblong, 3-5 per segment, inside globose leaf-balls which are 1-4 mm in diameter. INDUSIA lateral, hoodlike, opening toward the veins, somewhat leathery but withering early. SPORES bilateral.

Sterile fronds are similar to those of *Lorinseria areolata*, but they can be distinguished by the opposite pinnae and entire margins. Fronds intermediate between sterile and fertile ones are sometimes found, especially where the rhizome has been injured.

Ophioglossum vulgatum Linnaeus Plate 39

ADDER'S-TONGUE

O. pseudopodum, O. pycnostichum

NY, Vt, NH, Me, Mass, Ct, RI, NJ, Pa.

Moist meadows, damp woods, boggy places. Soil variable but mostly acid, pH usually 5-7.

RHIZOMES erect, bearing many fleshy roots and one to several fronds. FRONDS dimorphic, scattered, erect or bent in the bud (no croziers formed), 7-36 cm long, divided into sterile (below) and fertile (above) portions. STIPES (1.5-)6-13(-19) cm long, fleshy, green, with 3-6 obscure bundles at base which unite upward. STERILE BLADES oval to ovate, (1-)4-8(-12) cm long, (1-)2-3(-5) cm wide, sessile, not dissected, glabrous. VEINS reticulate. FERTILE BLADES linear-cylindric, 1-4 cm long, 0.2-0.5 cm wide. SORI of two rows of spherical sporangia, green when young. SPORES tetrahedral, spherical, sulfur-yellow.

This taxon may include two species in our area and is so treated by some authors.

Osmunda cinnamomea Linnaeus Plate 40

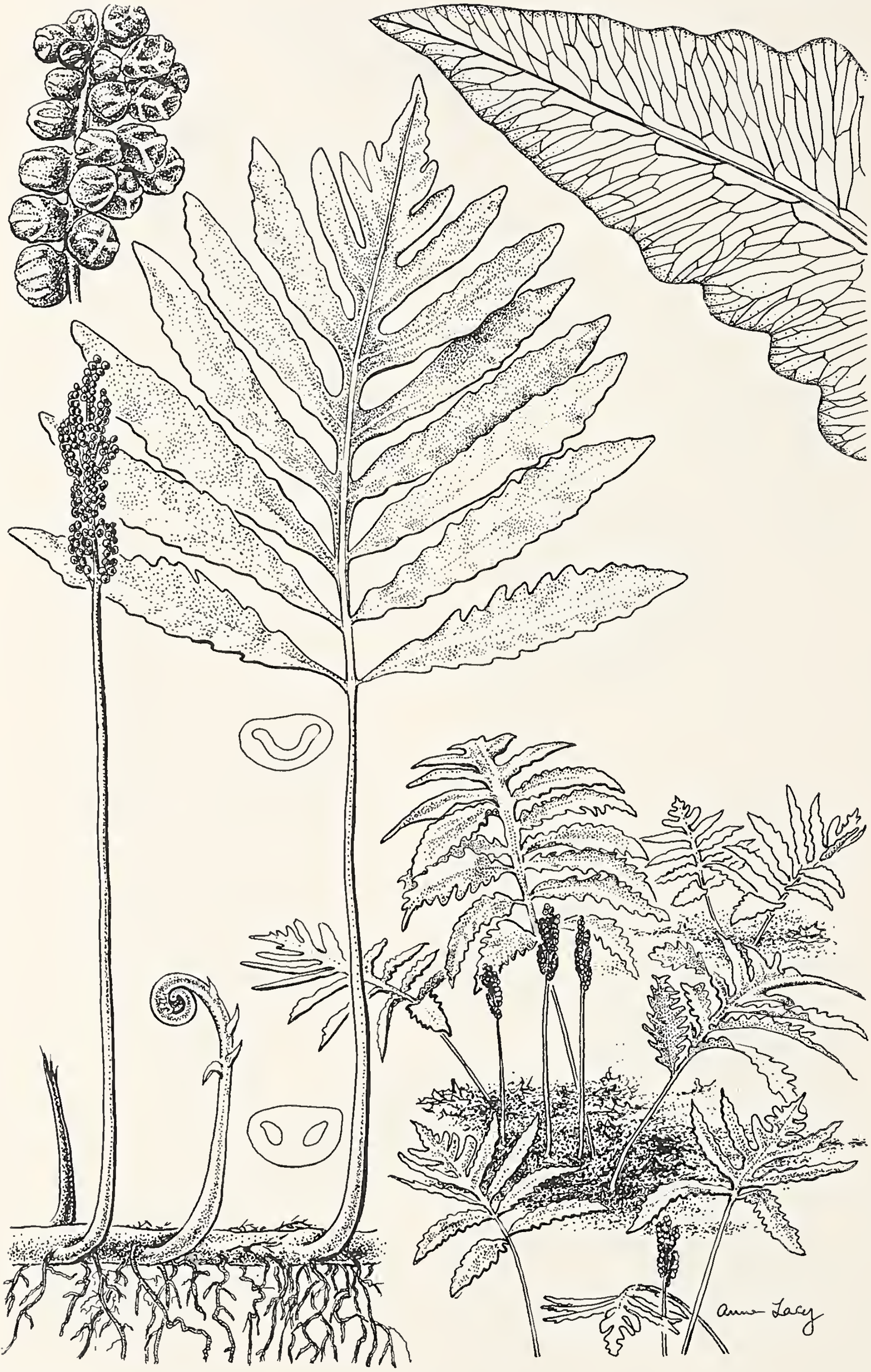
CINNAMON FERN

NY, Vt, NH, Me, Mass, Ct, RI, NJ, Pa.

Swamps, wet woods, boggy places, wet meadows. Soil acid, pH usually 4-6.

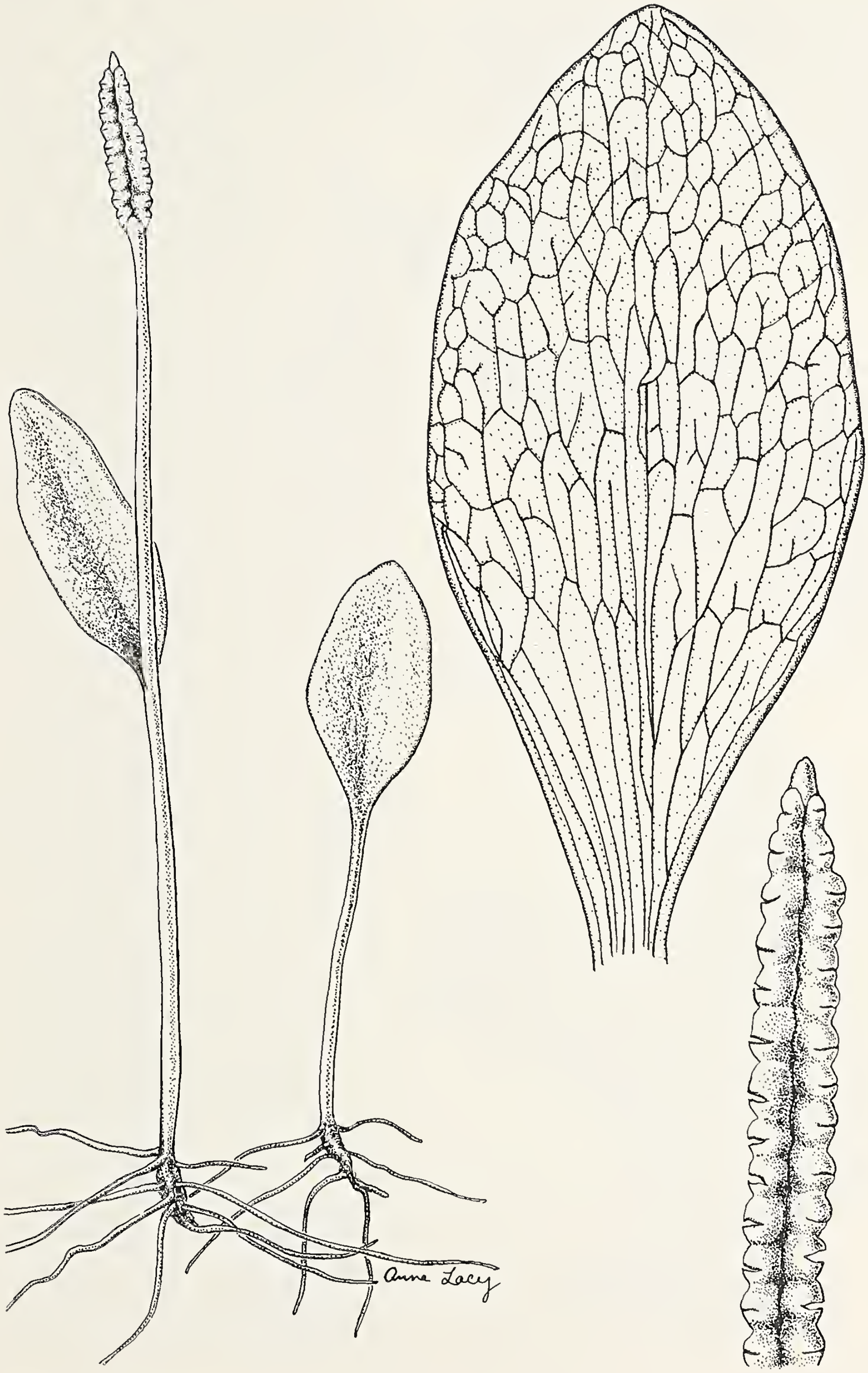
RHIZOMES large, short, without scales but covered with old roots and winged stipe bases. CROZIERS circular, about 2 cm in diameter, densely covered with whitish hairs which become cinnamon-brown. FRONDS dimorphic, clustered, 50-100 cm or more long, not evergreen. Fertile fronds surrounded by sterile fronds. STIPE of sterile fond shorter than the blade, 2-4.5 mm wide, greenish or pinkish, covered with cinnamon-brown hairs, without scales, with 1 horseshoe-shaped bundle that is much curled in at the ends. STERILE BLADES oblong-lanceolate to linear-lanceolate, 35-100 cm long, 13-25(-30) cm wide, pinnate-pinnatifid to nearly bipinnate; rachis hairy when young, becoming glabrous with age, except for a tuft of brownish hairs at the base of each pinna. STERILE PINNAE 15-25 pairs, alternate or opposite, oblong-lanceolate, mostly sessile, lowest pair shorter than middle ones. STERILE PINNULES (segments) 15-20 pairs on longest pinnae, apex obtuse or acutish, glabrous or with a few hairs, without scales; margins entire. VEINS of sterile pinnae free, forked, reaching the margin, 9-12 pairs per segment. FERTILE BLADES completely fertile, narrowly lanceolate to linear, 17-40 cm long, bipinnate, bright green when young, cinnamon-brown in age. SORI short-stalked, spherical, in clusters, confluent. INDUSIA absent. SPORES triplanate, spherical, green.

Plate 38



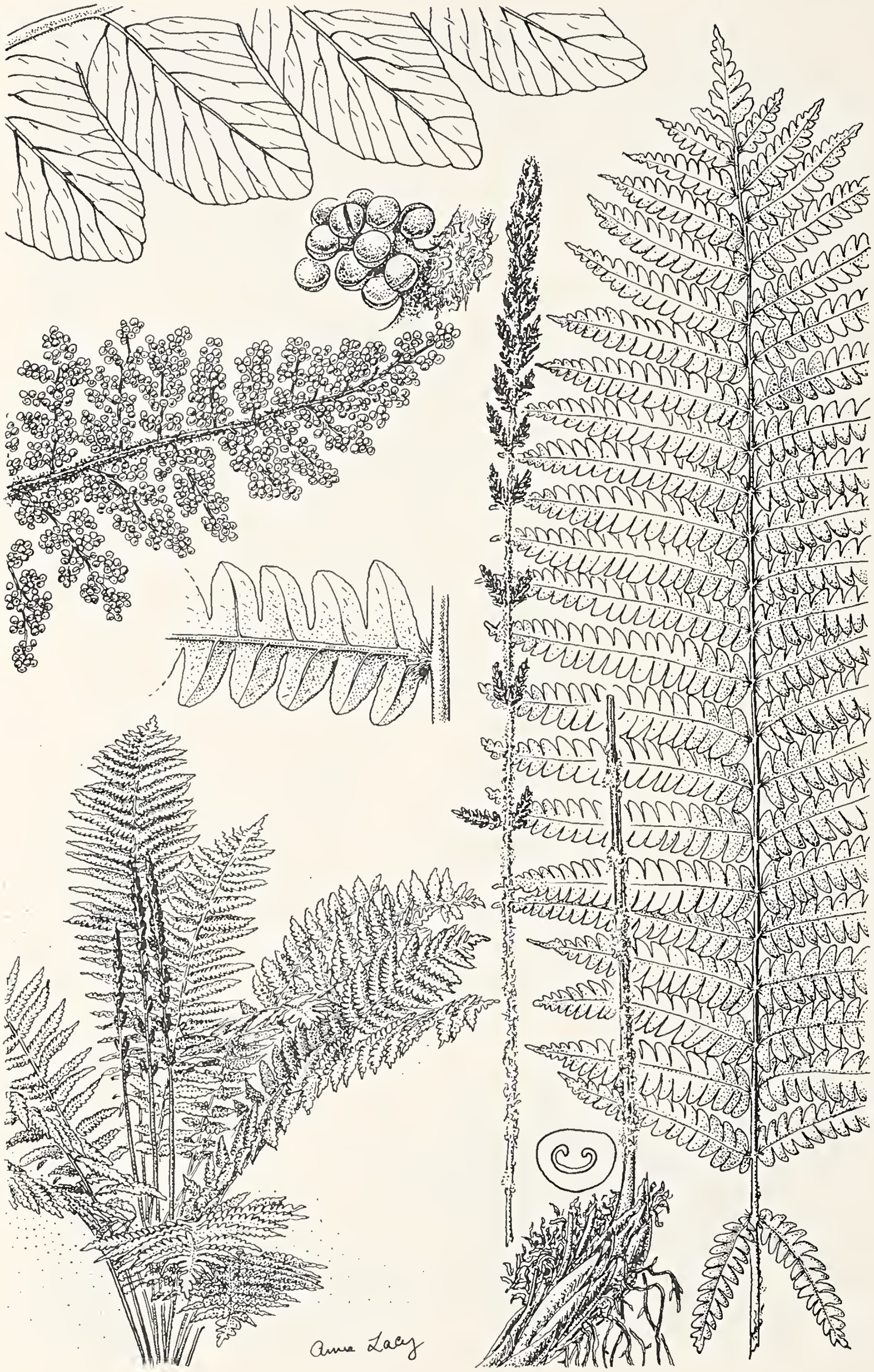
Onoclea sensibilis SENSITIVE FERN

Plate 39



Ophioglossum vulgatum ADDER'S-TONGUE

Plate 40



Osmunda cinnamomea CINNAMON FERN

Osmunda claytoniana Linnaeus Plate 41

INTERRUPTED FERN

NY, Vt, NH, Me, Mass, Ct, RI, NJ, Pa.

Moist woods, swamp margins, ditches, wet or dry meadows. Fertile fronds more often in open areas. Soil acid to neutral, pH mostly 5-7.

RHIZOMES large, creeping, without scales but covered with old roots and winged stipe bases. CROZIERS circular, about 2 cm in diameter, densely covered with whitish hairs when young, becoming brownish. FRONDS dimorphic, clustered, 40-180 cm long, sterile longer than the fertile, not evergreen. STIPE shorter than the blade, 2-5 mm wide, greenish or yellowish, hairy when young, becoming glabrous with age, with 1 horseshoe-shaped bundle that is much curled in at the ends. STERILE BLADES elliptic-oblong to broadly lanceolate, 45-90 cm long, 15-30 cm wide, pinnate-pinnatifid to nearly bipinnate; rachis with a few hairs (at least when young) but no tufts at the pinna bases. FERTILE BLADES differ only in that 1-3(-6) pairs of medial pinnae are replaced by fertile pinnae, covered with clusters of sporangia. STERILE PINNAE (on sterile and fertile blades) 10-25 pairs, alternate or opposite, oblong-lanceolate, mostly sessile, ascending, lowest pair shorter than middle ones. PINNULES (segments) 10-20 pairs on longest pinnae, apex obtuse, glabrous or with a few hairs, without scales; margins entire. VEINS free, forked, reaching the margin, 9-13 pairs per segment. SORI short-stalked, spherical, in clusters, confluent. INDUSIA absent. SPORES triplanate, spherical, green.

Osmunda regalis Linnaeus Plate 42

ROYAL FERN, FLOWERING FERN

NY, Vt, NH, Me, Mass, Ct, RI, NJ, Pa.

Low woods, marshes, swamps. Soil usually very acid but sometimes nearly neutral, pH mostly 4-6.

RHIZOMES large, short, woody, erect to suberect, without scales but with old roots and stipe bases. CROZIERS densely covered with brown hairs when young, soon becoming glabrous, reddish. FRONDS dimorphic, clustered, 50-180(-350) cm long, not evergreen. STIPE shorter than or about the same length (sometimes longer) as the blade, 2.5-5 mm wide, greenish or straw-colored or reddish, without hairs or scales, with 1 horseshoe-shaped bundle that is much curled in at the ends. BLADES with sterile pinnae below and fertile pinnae above, broad-ovate or broad-elliptic, (20-)25-75(-150) cm long, (15-)25-40(-55) cm wide, bipinnate; rachis with hairs, without scales. STERILE PINNAE opposite or nearly so, (2-)5-7 pairs, oblong to ovate-lanceolate, with short stalks, 15-30 cm long, 5-15 cm wide, lowest pair slightly shorter than middle ones. PINNULES 7-10 pairs, alternate or subopposite, oblong, sometimes slightly auriculate, sessile or with a short stalk, without hairs or scales; margins serrulate to nearly entire. VEINS free, forked, reaching the margin. SORI in short-stalked clusters. INDUSIA absent. SPORES triplanate, spherical, green when young.

A hybrid, *O. claytoniana* × *regalis*, has been found in Connecticut.

Pellaea atropurpurea (Linnaeus) Link Plate 43

PURPLE CLIFF BRAKE

NY, Vt, Mass, Ct, RI (rare), NJ, Pa.

Ledges and talus slopes, mostly on limestone, sometimes on cement walls. Soil neutral to alkaline.

RHIZOMES short, branched, scaly. FRONDS usually distinctly dimorphic, clustered, 8-45 cm long, evergreen. STIPE about 1/2 to 2/3 as long as blade, (1-)5-25 cm long, wiry, purplish or reddish, shiny, rough-hairy or nearly glabrous, with 1 linear, curved bundle. BLADES leathery, grayish green, triangular-ovate to oblong or lanceolate, 10-20(-35) cm long, 5-10(-20) cm wide, pinnate above, bipinnate below; rachis with rough hairs, dark brown. PINNAE 5-11 pairs, opposite or nearly so, lowest pair as long as pair above (or longer) with 1-9 pinnules. PINNULES ovate, sometimes triangular or hastate, glabrous or with a few hairs; margins entire. VEINS free, forked or not, reaching the margin. SORI marginal or nearly so, circular or oblong, separate or confluent. INDUSIA absent but with an indusium-like reflexed margin of the pinnule. SPORES tetrahedral.

Pellaea glabella Mettenius Plate 44

SMOOTH CLIFF BRAKE

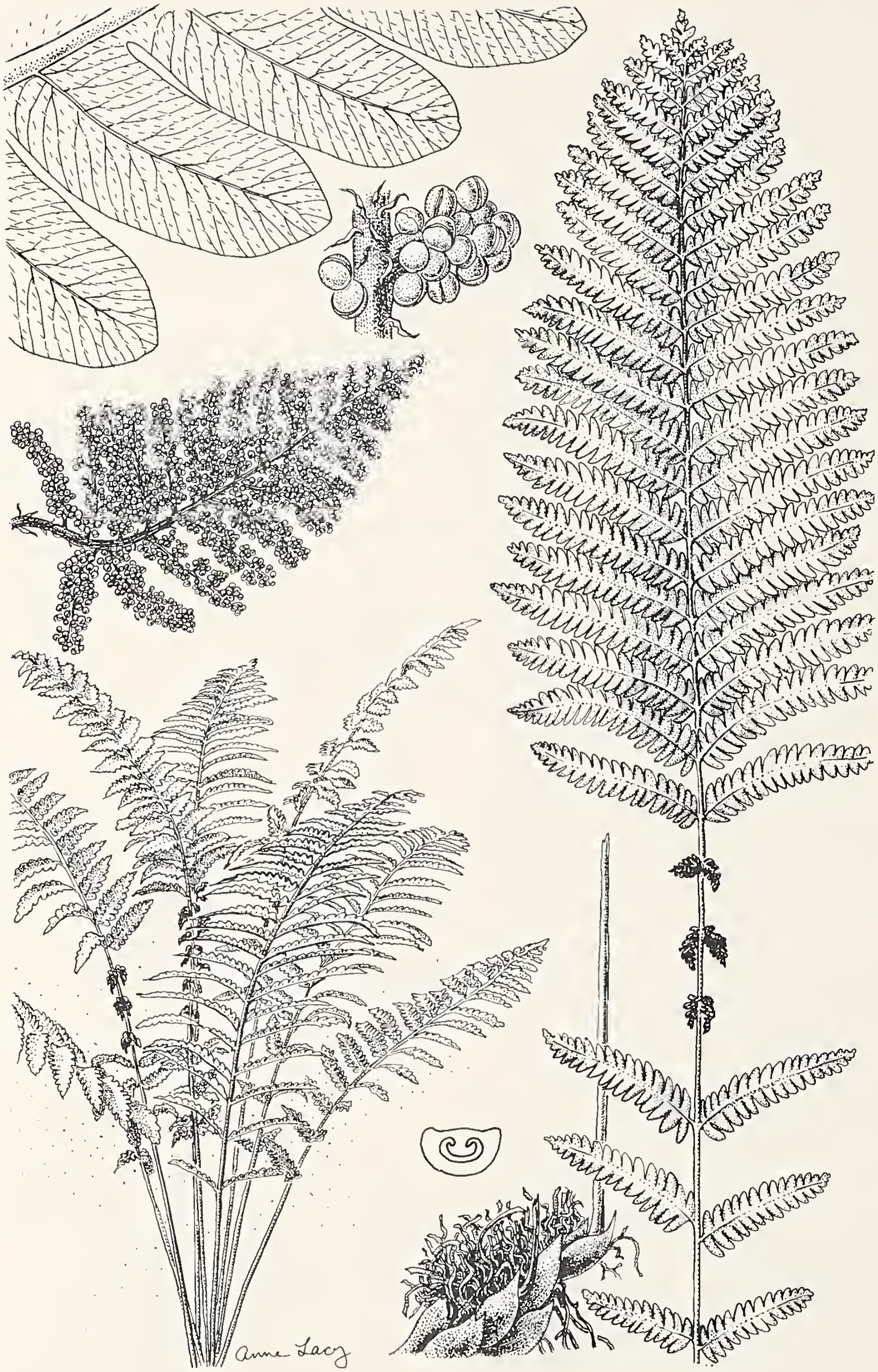
P. atropurpurea var. *g.*

NY, Vt (rare), NJ, Pa.

Shaded ledges and damp talus slopes, mostly on limestone, but also on shale and sandstone. Soil mostly neutral.

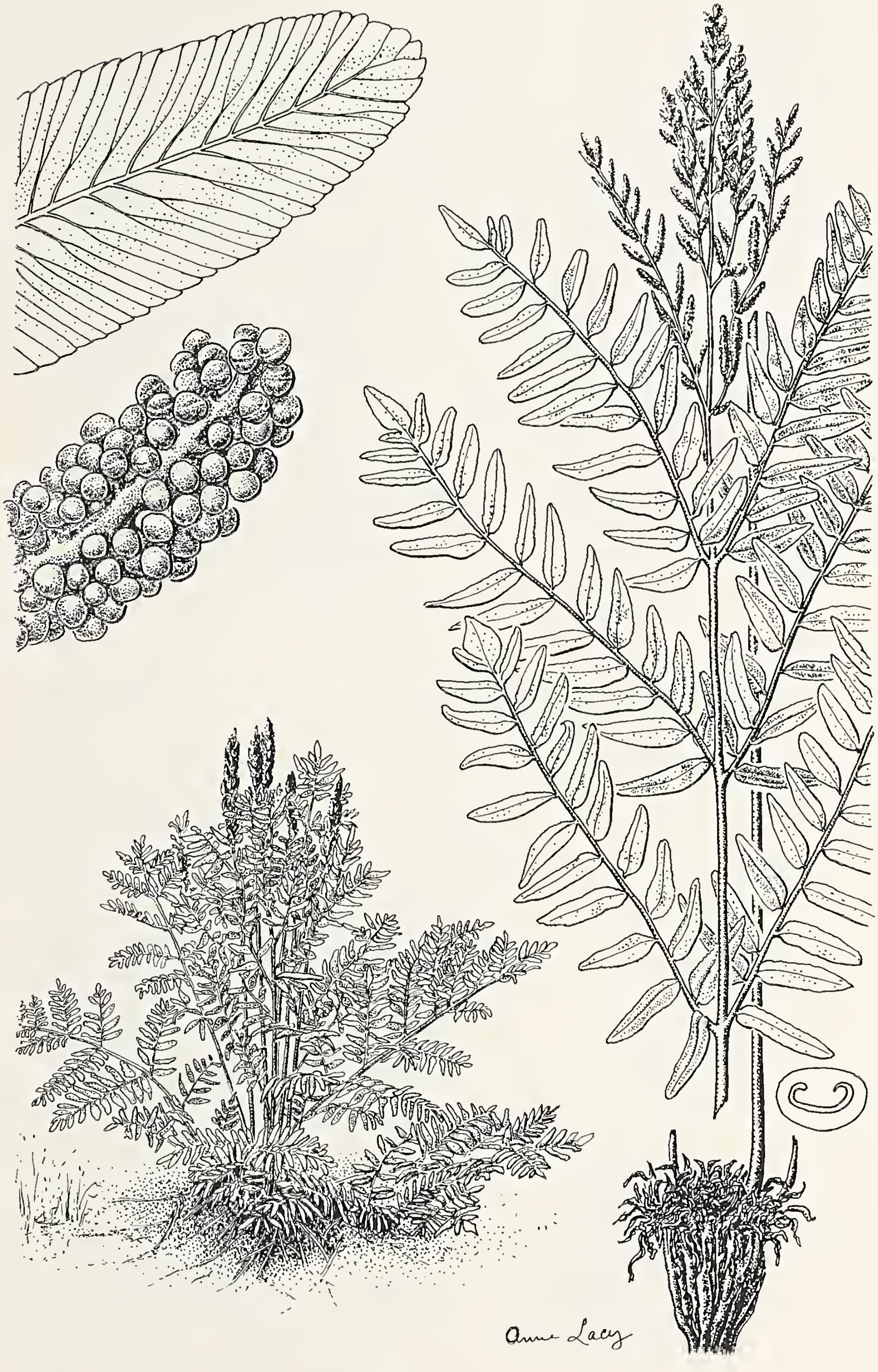
RHIZOMES short, branched, scaly. FRONDS not strongly dimorphic, clustered, 5-30 cm long, evergreen. STIPE dark reddish brown, shiny, usually about 1/2 to 2/3 as long as blade, mostly 5-20 cm long, wiry, glabrous or with a few spreading hairs, with a few long narrow scales, with 1 linear curved bundle. BLADES leathery, bluish green, narrowly oblong or narrowly ovate, 6-12 cm long, 2-5(-8) cm wide, pinnate

Plate 41



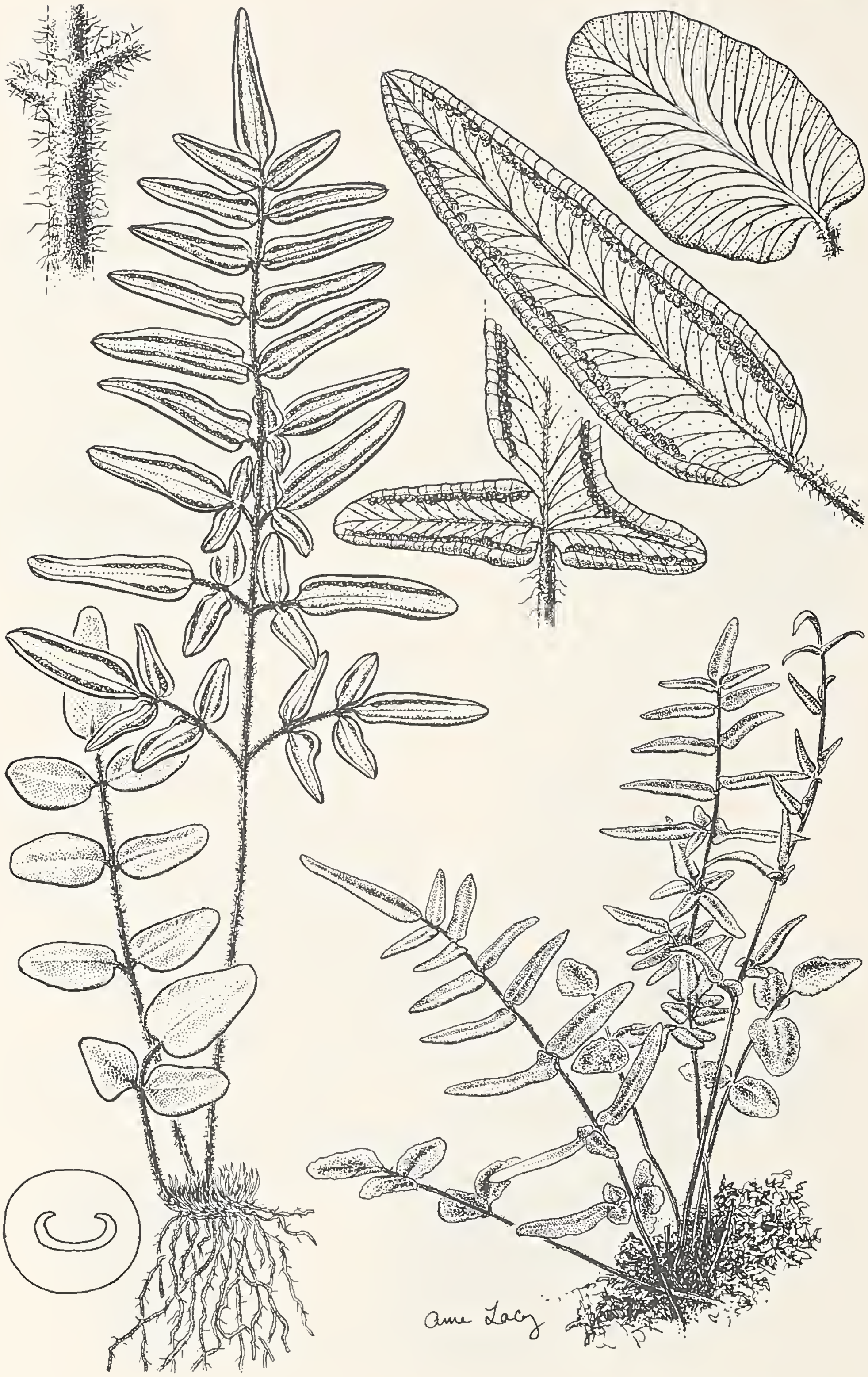
Osmunda claytoniana INTERRUPTED FERN

Plate 42



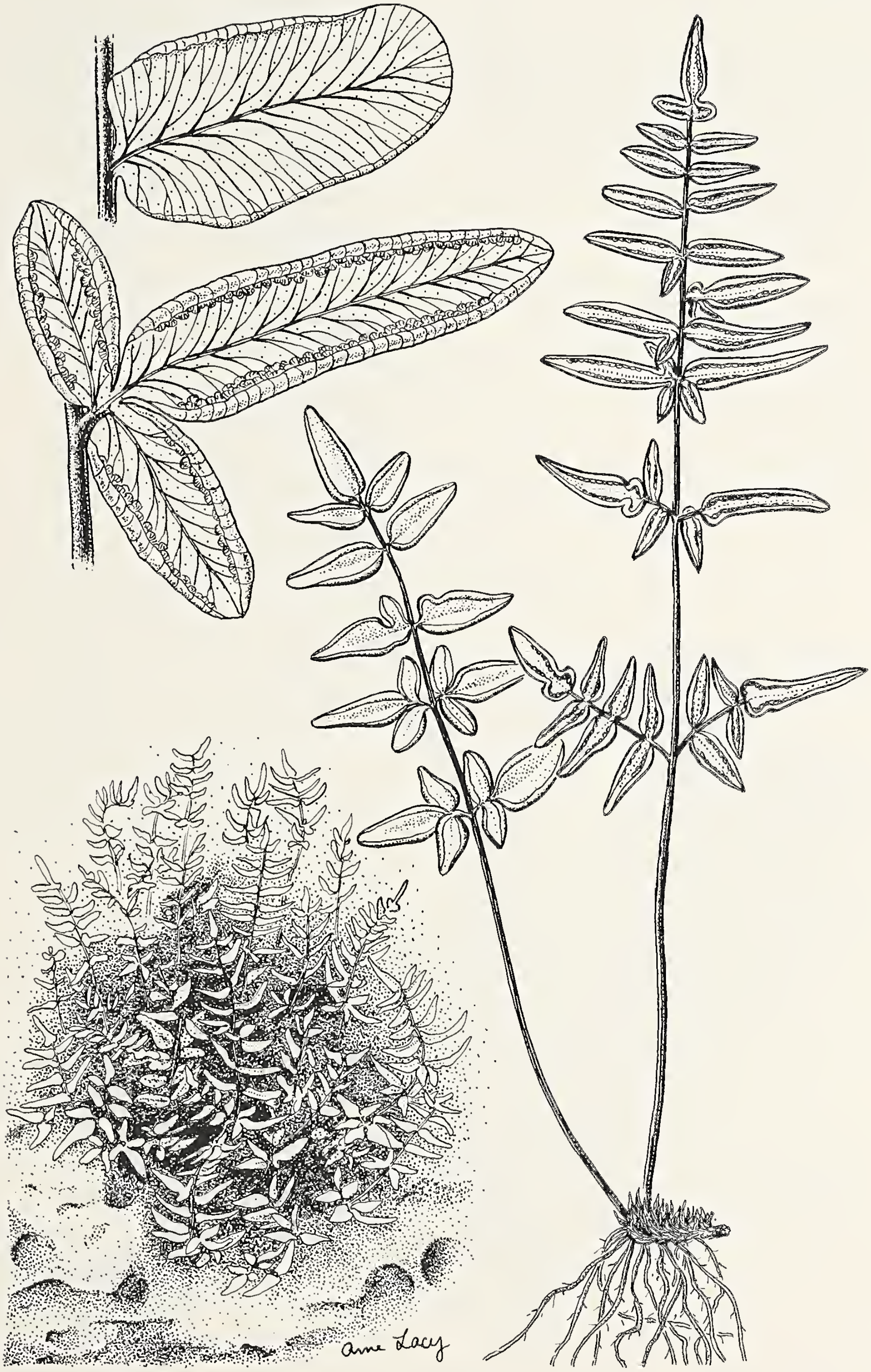
Osmunda regalis ROYAL FERN

Plate 43



Pellaea atropurpurea PURPLE CLIFF BRAKE

Plate 44



Pellaea glabella SMOOTH CLIFF BRAKE above, bipinnate below; rachis glabrous or nearly so, shiny brown. PINNAE 5-10 pairs, opposite or nearly so, lowest pair about as long as the pair above and with 1-3(-5) pinnules. PINNULES mostly ovate, glabrous; margins entire. VEINS free, forked or not, reaching the margin. SORI marginal or nearly so, circular or oblong, separate or confluent. INDUSIA absent but with an indusium-like reflexed margin of the pinnule. SPORES tetrahedral.

Similar to *P. atropurpurea* and by some authors treated as a variety of that species.

Phegopteris connectilis (Michaux) Watt Plate 45

LONG BEECH FERN, NORTHERN BEECH FERN

P. polypodioides, Dryopteris phegopteris, Thelypteris phegopteris

NY, Vt, NH, Me, Mass, Ct, RI, NJ, Pa.

Moist rocky woods, cliffs, below dripping ledges, under small waterfalls, etc. Soil variable but mostly acid.

RHIZOMES slender, cordlike, widely creeping, 1-3 mm in diameter, densely covered with hairs and scales when young, losing them with age. FRONDS not dimorphic, solitary or a few in clusters, 8-50(-60) cm long, not evergreen. Mature STIPE longer than the blade, with hairs and scales throughout, with 2 oval or short-linear bundles at base, these united upward to form a curved bundle. BLADES triangular, about 2/3 as wide as long, (4-)10-20(-30) cm long, (2-)10-15(-25) cm wide, pinnate-pinnatifid; rachis with a few hairs on both sides and with scales on the under side. PINNAE opposite or nearly so, all except lowest 1 or 2 pinnae pairs broadly sessile at the rachis, basal pair usually pointed downward, with many hairs and scales; margins entire, sometimes ciliate. VEINS free, not or once forked, reaching the margin. SORI submarginal or not marginal, circular, separate. INDUSIA absent. SPORES bilateral.

Phegopteris hexagonoptera (Michaux) Fée Plate 46

BROAD BEECH FERN, SOUTHERN BEECH FERN

Dryopteris hexagonoptera, Thelypteris h.

NY, Vt, NH, Me, Mass, Ct, RI, NJ, Pa.

Moist or dryish, rich woods and glades. Soil acid, pH usually 5-6.

RHIZOMES slender, cordlike, creeping, 2-4 mm in diameter, densely scaly and with a few hairs. FRONDS not dimorphic, solitary at 5-15 mm intervals, 30-60(-90) cm long, not evergreen. Mature STIPE longer than the blade, glabrous or with a few hairs and scales, with 2 oval or short-linear bundles at base, these united upward to form a curved bundle. BLADES broadly triangular, mostly as wide or wider than long, 10-40 cm long, 15-40 cm wide, pinnate-pinnatifid above to bipinnate-pinnatifid below; rachis with a few whitish or pale brown hairs. PINNAE opposite or nearly so, the pairs joined at the winged rachis, basal pair usually pointed downward, with a few hairs and scales; margins entire, sometimes ciliate. VEINS free, unbranched to several times forked, reaching the margin. SORI submarginal or not marginal, circular, separate. INDUSIA absent. SPORES bilateral.

Phyllitis scolopendrium (Linnaeus) Newman Plate 47

HART'S-TONGUE

NY (rare).

Shaded, limestone cliffs and depressions. Soil neutral or nearly so.

RHIZOMES erect, scaly. FRONDS not dimorphic, clustered, 10-40 cm long, evergreen. STIPE shorter than blade, 4-12 cm long, 1-2 mm wide, with scales when young, with 2 linear, curved bundles at base, these united upward form an X-shaped bundle. BLADES broad-linear, often cordate-auriculate at base, 15-35 cm long, 2-5 cm wide, not dissected, with a few scales on the undersides, especially along their midveins; margins entire. VEINS pinnate, free, forked. SORI not marginal, linear, oblique to the midvein, 3-20 mm long, separate. INDUSIA laterally attached. SPORES bilateral.

Polypodium virginianum Linnaeus Plate 48

COMMON POLYPODY, ROCK POLYPODY

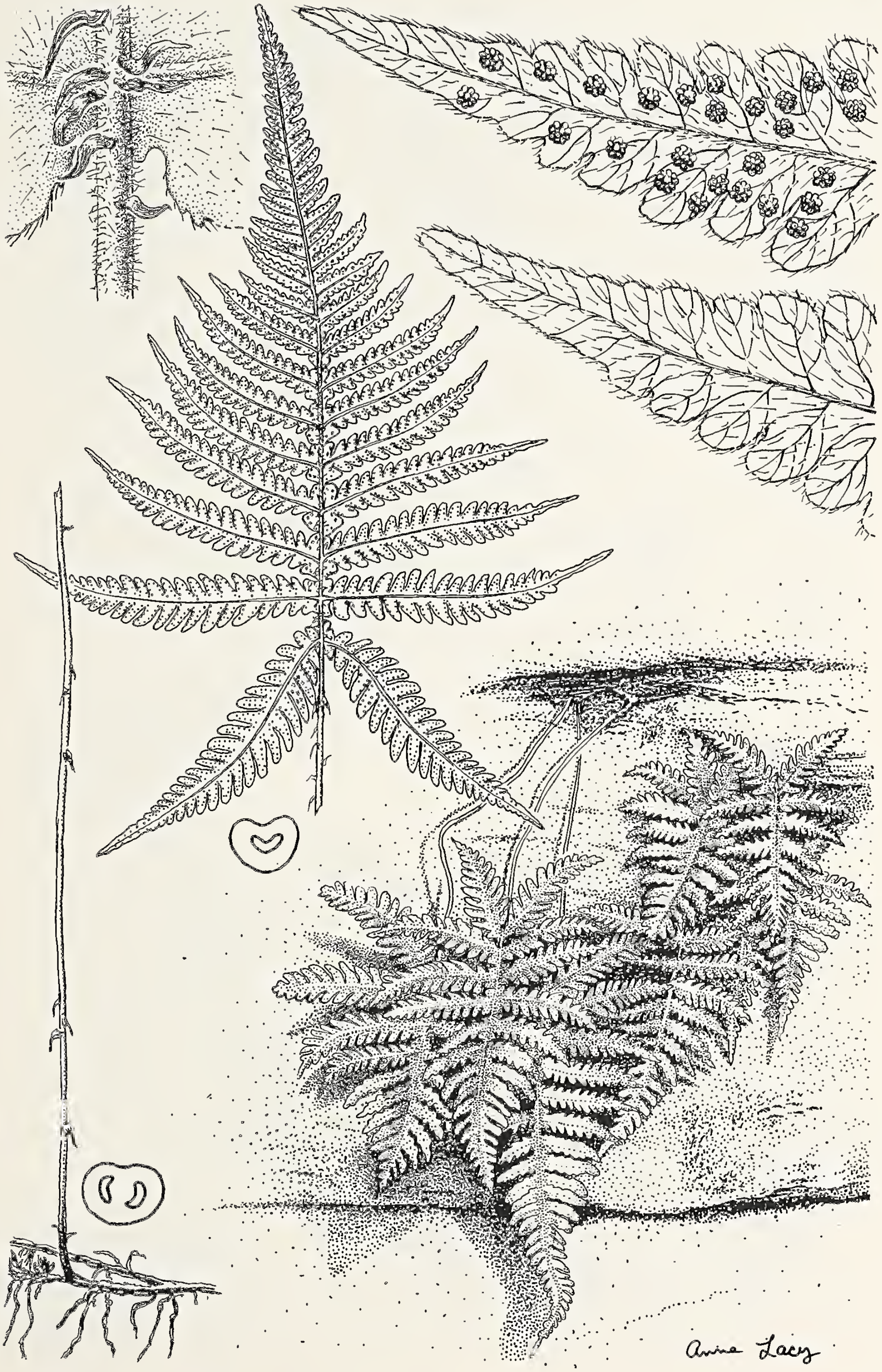
P. vulgare

NY, Vt, NH, Me, Mass, Ct, RI, NJ, Pa.

Thin soil (shallow leaf mold) on large rocks and cliffs, rocky banks, sometimes on fallen logs or tree bases, in open woods or swamps. Soil variable, acid to alkaline.

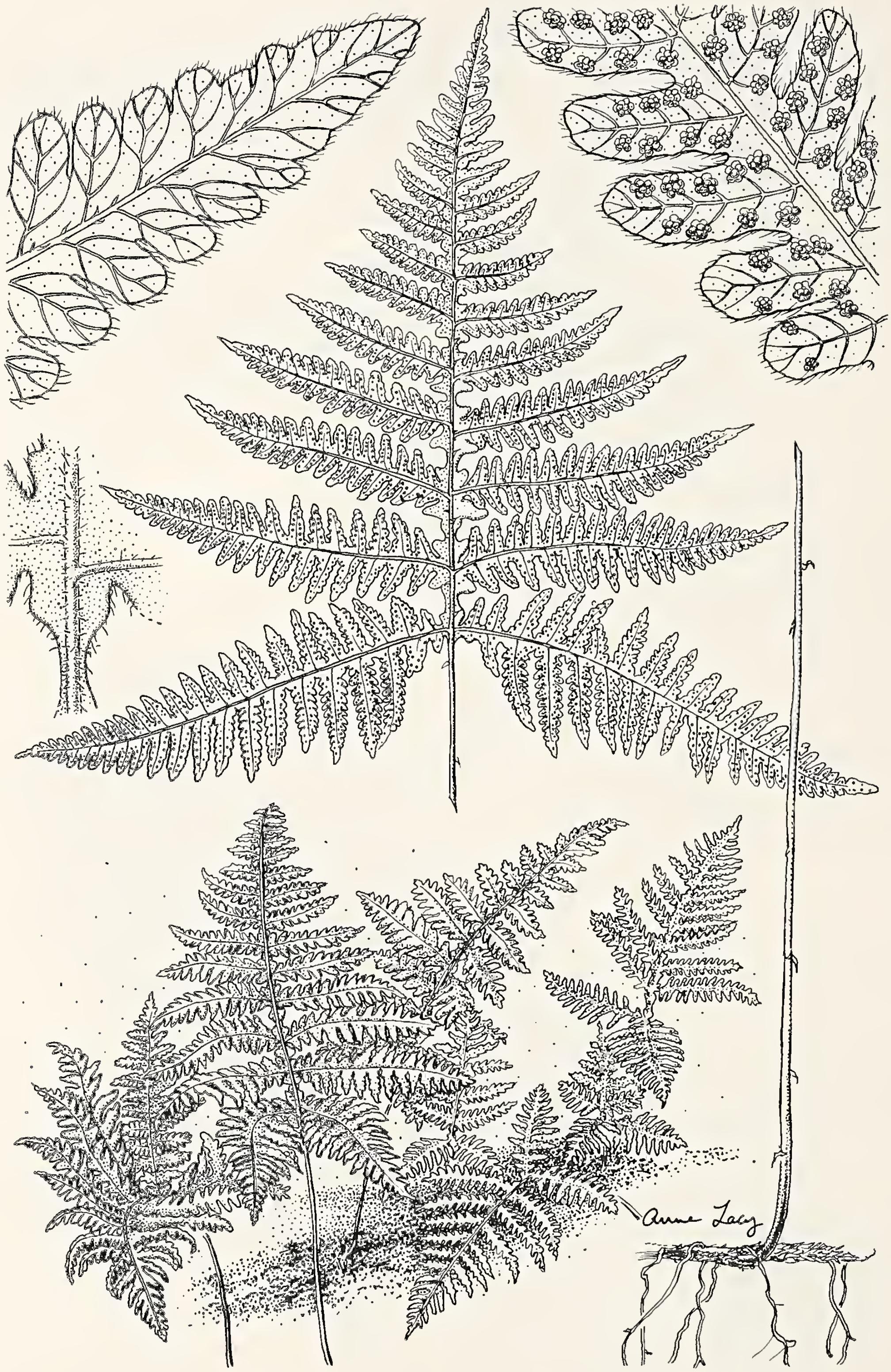
RHIZOMES ropelike, spongy, branched, often partly exposed and matlike, 2-7 mm in diameter, densely covered with brown scales. FRONDS not dimorphic, rising separately from points on the rhizome, mostly 10-30 cm long, evergreen and persistent after new fronds appear. STIPE usually about 2/3 as long as blade, glabrous, scurfy, with scales only at base, with 3 circular bundles at extreme base, these united near the base to 2 and then to 1 toward the blade. BLADES oblong-lanceolate, 5-20(-25) cm long, 2-6 cm wide, pinnatifid or pinnate (rarely pinnate-pinnatifid), rachis winged, without scales, or rarely with a few.

Plate 45



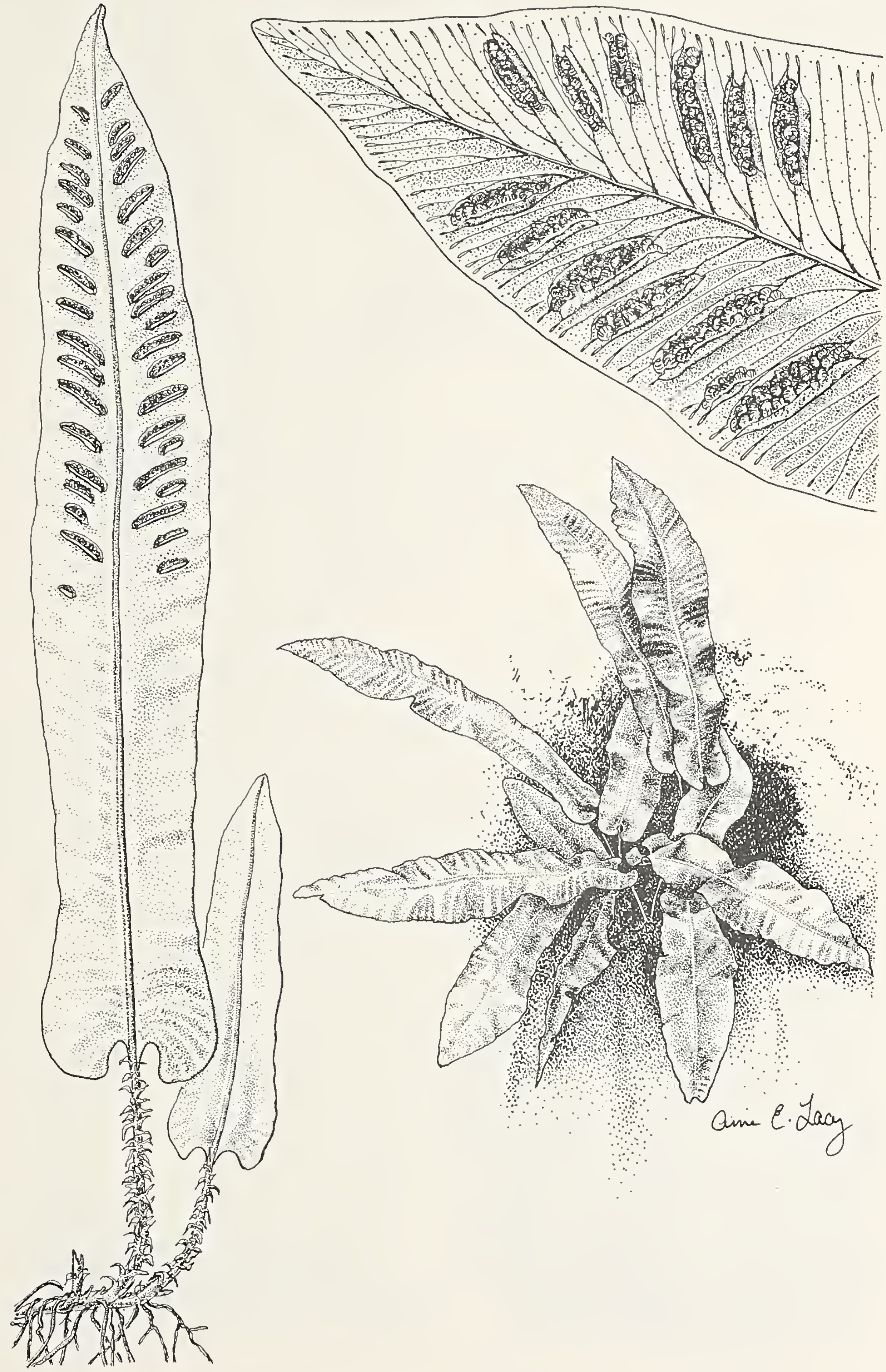
Phegopteris connectilis LONG BEECH FERN

Plate 46



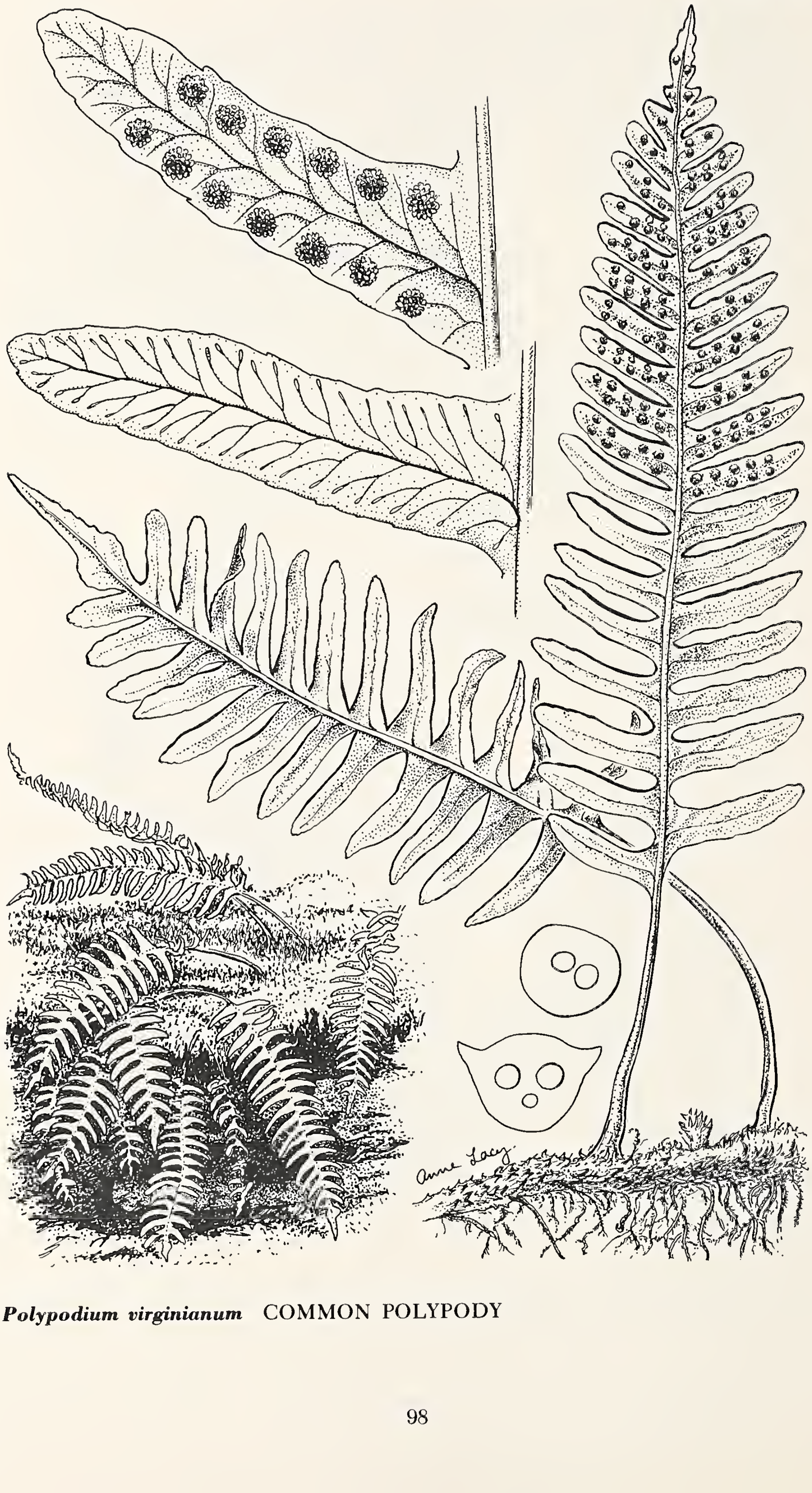
Phegopteris hexagonoptera BROAD BEECH FERN

Plate 47



Phyllitis scolopendrium HART'S-TONGUE

Plate 48



Polypodium virginianum COMMON POLYPODY

PINNAE (segments) mostly alternate, 10-20 pairs, linear-oblong, glabrous; margins entire or slightly undulate-dentate with shallow teeth. VEINS free, forked, enlarged at apex, not reaching the margin. SORI not marginal, but they may appear marginal because of their large size, usually separate. INDUSIA absent. SPORES bilateral.

Polystichum acrostichoides (Michaux) Schott Plate 49

CHRISTMAS FERN

NY, Vt, NH, Me, Mass, Ct, RI, NJ, Pa.

Moist shady areas in rocky woods. Can tolerate sun if soil is moist. Soil acid to neutral, pH usually 5-7.

RHIZOMES stout, short, creeping and ascending, 6-10 mm in diameter, scaly and with old stipe bases and wilted fronds. CROZIERS about 1 cm in diameter, with long silvery-white scales. FRONDS somewhat dimorphic in that those with fertile pinnae are longer than the completely sterile fronds and the fertile pinnae are smaller and only at the upper part of the blade, clustered, (10-)30-75(-150) cm long, evergreen. STIPE ¼ to ½ as long as the blade, brown at base, green above, densely covered with persistent scales, with 4 or 5 circular bundles at base and upward. BLADES dark green, usually lanceolate, (15-)20-50(-70) cm long, 4-13 cm wide, pinnate (typical form); rachis green, scaly. PINNAE leathery, opposite at base, alternate above, (10-)20-35 pairs, linear-oblong, acute at apex, each base with an auricle on the upper side, lowest pair about the same length, or slightly shorter than middle pinnae, glabrous on the upper side, with scales (some hairlike) on the underside; margins with small or large bristle-tipped teeth. VEINS free, forked, reaching the margin. SORI not marginal, in two rows along the midvein, circular, separate but crowded, confluent at maturity. INDUSIA circular, with a wavy margin, peltate, shrivel and disappear with age. SPORES bilateral.

Many variations in pinna shape and dissection may be found.

Polystichum lonchites, NORTHERN HOLLY FERN, is represented in our area by a single fragmentary collection from western New York. It has not been reported since 1940.

Polystichum braunii (Spenner) Fée Plate 50

BRAUN'S HOLLY FERN

NY, Vt, NH, Me, Mass, Pa.

Cool, moist rocky humus-rich woods and ledges. Soil neutral or nearly so.

RHIZOMES stout, short, erect, about 5 mm in diameter, scaly, and with old stipe bases. CROZIERS for the next year's fronds formed during late summer, covered with silvery white scales. FRONDS not dimorphic, clustered, 30-90(100) cm long, not or semi-evergreen. STIPE about ¼ as long as blade, yellow-green to brown, densely covered with scales and with a few hairs, with 4 or 5 circular or oval bundles at base and upward. BLADES dark green, elliptic, 25-70(-90) cm long, 7-20 cm wide, mostly bipinnate; rachis scaly and with long hairs. PINNAE leathery, nearly opposite at base, alternate above, (20-)30-40 pairs, linear-lanceolate, acute at apex, lowest pair much shorter than middle pinnae. PINNULES ovate-oblong to ovate-triangular, acute at apex, slightly auriculate at base, with scales and hairs on the midveins; margins with incurved, bristle-tipped teeth. VEINS free, forked, reaching the margin, with linear scales. SORI on the vein forks, not marginal, circular, separate. INDUSIA circular, peltate, with wavy margins. SPORES bilateral.

Pteridium aquilinum (Linnaeus) Kuhn Plate 51

BRACKEN, BRAKE FERN

P. latiusculum

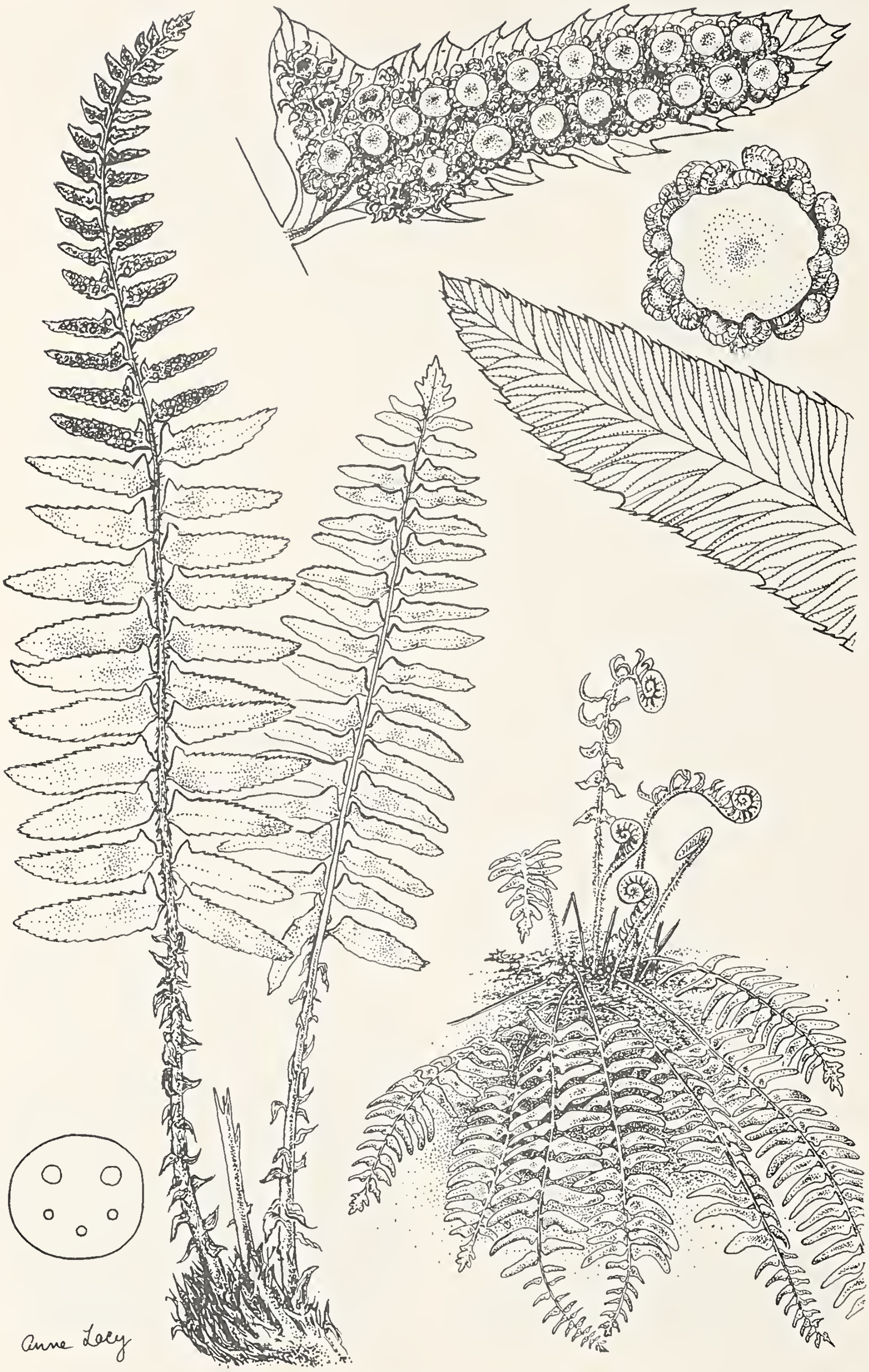
NY, Vt, NH, Me, Mass, Ct, RI, NJ, Pa.

Dry, sandy or sterile soil of fields, sometimes invading open woods. Soil acid to neutral.

RHIZOMES cordlike, branched, blackish, 5-15 mm in diameter, without scales, often with a few hairs at the growing tip. CROZIERS in groups of three, covered with silvery-gray hairs. FRONDS not dimorphic, scattered on the rhizome, 20-100(-150) cm long, not evergreen. STIPE woody, variable in length, dark purple-brown at base, straw-colored above, glabrous, or with a few hairs at base, with several (often more than 10) bundles of various sizes, shapes, and arrangements, some of which unite upward. BLADES broad-triangular to ovate, (12-)20-50(-100) cm long, (15-)35-75 cm wide, often ternate, bipinnate-pinnatifid to tripinnate-pinnatifid; rachis glabrous or nearly so. PINNAE opposite, the basal pair much larger than the others. PINNULES oblong-linear, glabrous or with a few hairs on midveins and margins; margins curled inward, entire. VEINS free, forked, reaching the margin. SORI marginal, linear, nearly continuous (a fungus that appears on the underside of the pinnules must not be mistaken for sori). INDUSIA the reflexed margin of the pinnule, silvery-white, delicate. SPORES tetrahedral.

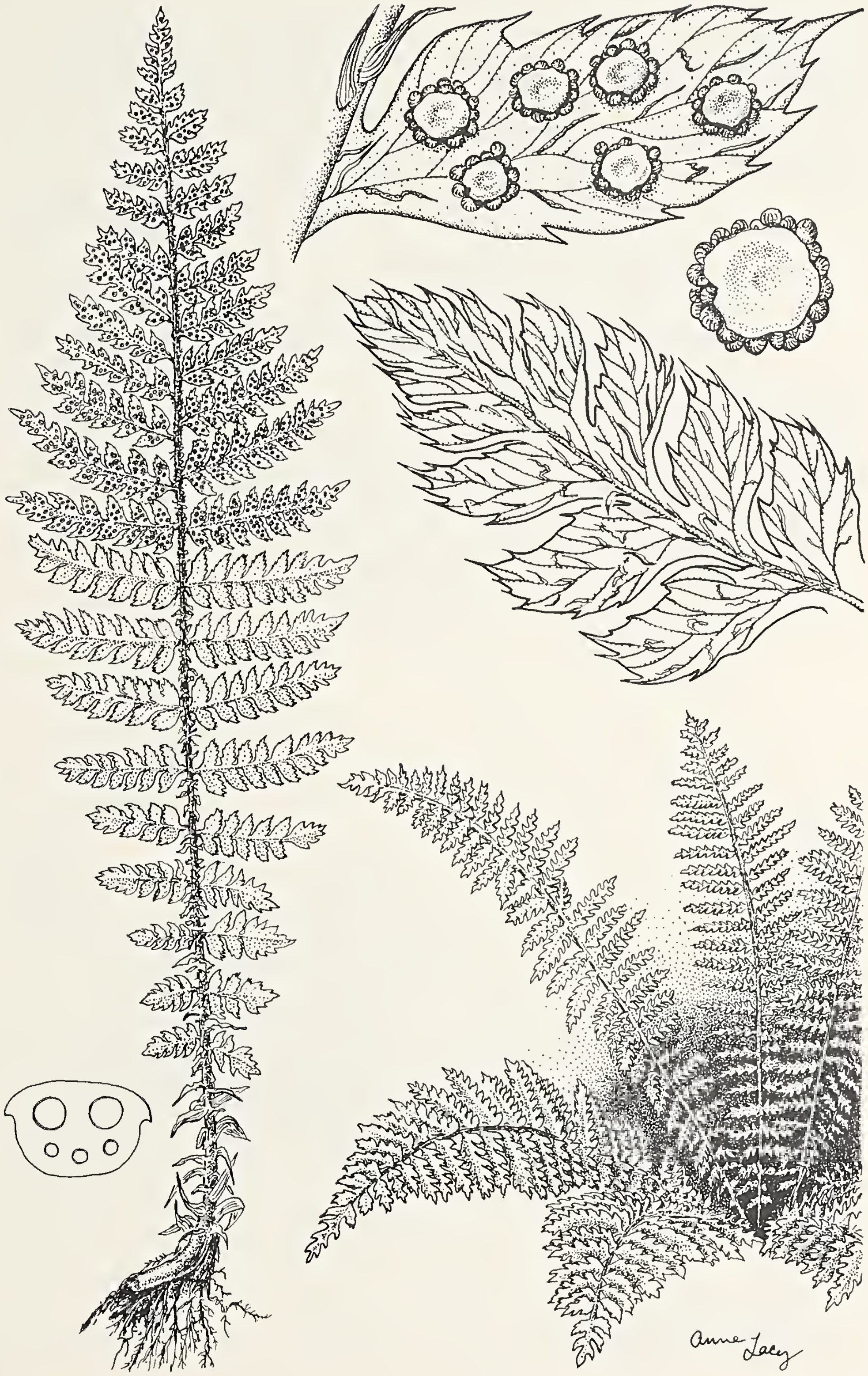
Very common and weedy.

Plate 49



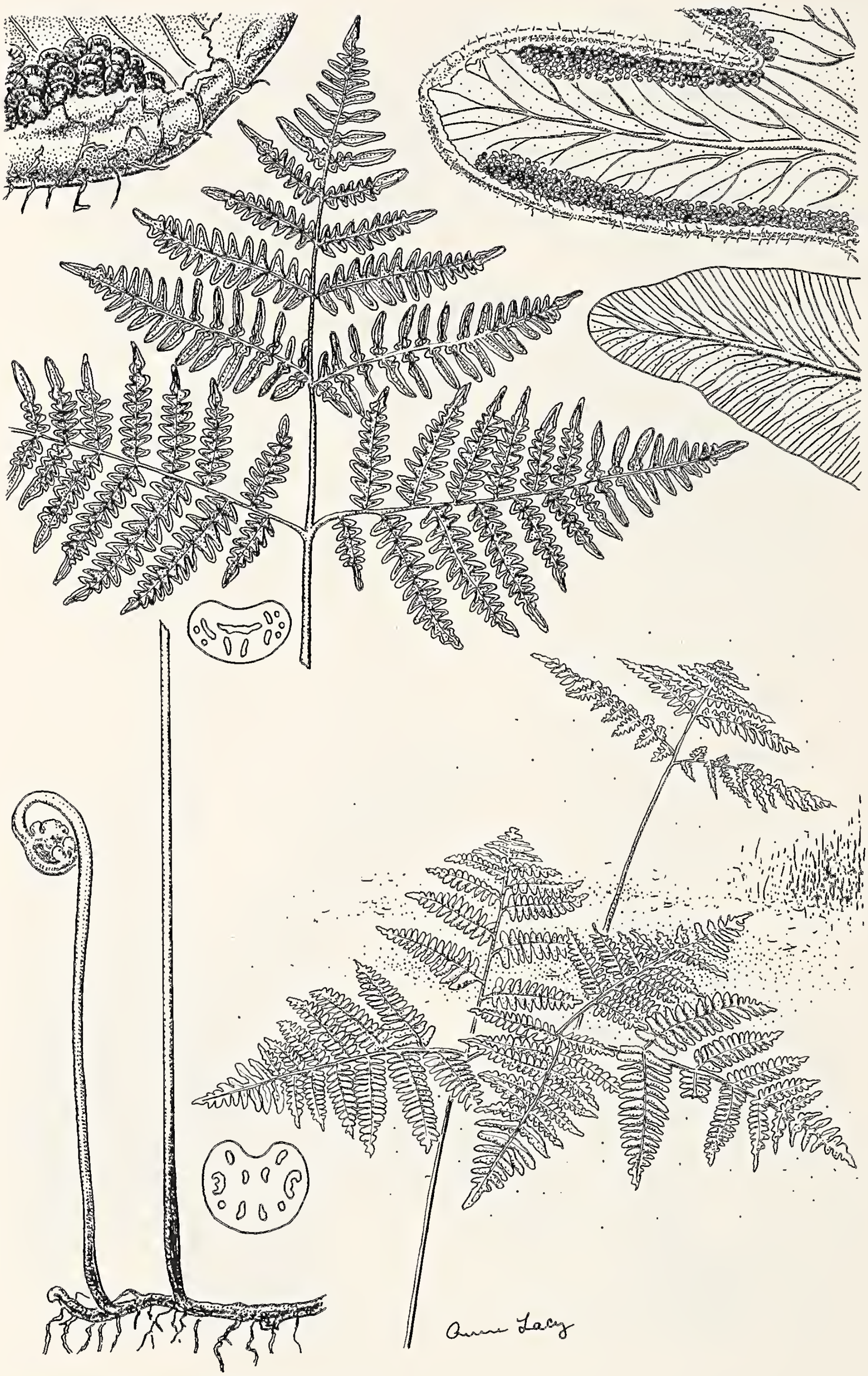
Polystichum acrostichoides CHRISTMAS FERN

Plate 50



Polystichum braunii BRAUN'S HOLLY FERN

Plate 51



Pteridium aquilinum BRACKEN

Schizaea pusilla Pursh Plate 52

CURLY GRASS

NY (rare), NJ.

Bogs, wet grassy depressions, hummocks of mossy humus in sandy areas. Soil very acid.

RHIZOMES short, erect. FRONDS not fernlike, dimorphic, clustered, STERILE FRONDS linear, filiform, 1-6 cm long, 1 mm wide or less, with no distinction between stipe and blade, curled, glabrous. FERTILE FRONDS 2-12 cm long, stipe much longer than blade. FERTILE BLADES 2-4 mm long, pinnate, comblike, with about 4-7 pairs of pinnae. PINNAE 1.5-4 mm long. SPORANGIA 8-14 per pinna. SPORES oval, 85-100 microns in longest diameter, surface granular-pitted.

Thelypteris noveboracensis (Linnaeus) Nieuwland Plate 53

NEW YORK FERN

Dryopteris n.

NY, VT, NH, Me, Mass, Ct, RI, NJ, Pa.

Moist or dryish, shady, rich woods or glades and edges of swamps. Soil moderately acid.

RHIZOMES slender, cordlike, branching, 1.5-2.5 mm in diameter, scales few or absent. FRONDS not dimorphic, solitary and scattered or 3 or 4 in a cluster, 25-70(-90) cm long, not evergreen. STIPE much shorter than blade, glabrous or with a few hairs, scaly at base, with 2 oval or short-linear bundles at base, these united upward to form a curved bundle. BLADES elliptic, 20-50 cm long, 8-15 cm wide, pinnate-pinnatifid to nearly bipinnate; rachis glabrous or with a few hairs on the underside, without scales. PINNAE linear-lanceolate, sessile, lowest very short. PINNULES (segments) linear-oblong, with a few hairs on the veins; margins entire or nearly so, ciliate. VEINS free, not forked on sterile segments, rarely forked on fertile segments, reaching the margin. SORI not marginal but usually nearer the margin than the midvein, circular, separate or rarely confluent. INDUSIA reniform, often circular but with a sinus, persistent but may shrink with age, ciliate. SPORES bilateral.

Thelypteris palustris Schott Plate 54

MARSH FERN

T. thelypteris, T. thelypterioides, Dryopteris thelypteris

NY, Vt, NH, Me, Mass, Ct, RI, NJ, Pa.

Marshes, swamps, bog margins, wet woods, low meadows. Soil usually slightly acid.

RHIZOMES slender, creeping, 1-2 mm in diameter, with very few scales. FRONDS slightly dimorphic, in that fertile fronds usually have longer stipes and the pinna segments are narrrower with partially inrolled margins, borne singly and scattered on the rhizome, (10-)20-80(-120) cm long, not evergreen. STIPE shorter or longer than the blade, glabrous or nearly so, with a few scales when young, with 2 circular or oval bundles at base, these united upward. BLADES oblong-lanceolate, 10-40 cm long, 8-20 cm wide, pinnate-pinnatifid to bipinnate; rachis with tiny hairs. PINNAE linear-lanceolate, sessile or with a short stalk, lowest pair about same length or slightly shorter than middle pinnae. PINNULES (segments) with some tiny hairs on the midveins, at least when young, sometimes with a few scales on the midveins; margins entire or shallowly dentate. VEINS free, forked (at least on sterile segments), reaching the margin. SORI not marginal, circular, near the midvein, enclosed by the inrolled pinna margin when young, separate but crowded, confluent with age. INDUSIA reniform, often circular, but with a sinus, fragile, usually slightly ciliate, shriveling or disappearing with age. SPORES bilateral.

Thelypteris simulata (Davenport) Nieuwland Plate 55

MASSACHUSETTS FERN, BOG FERN

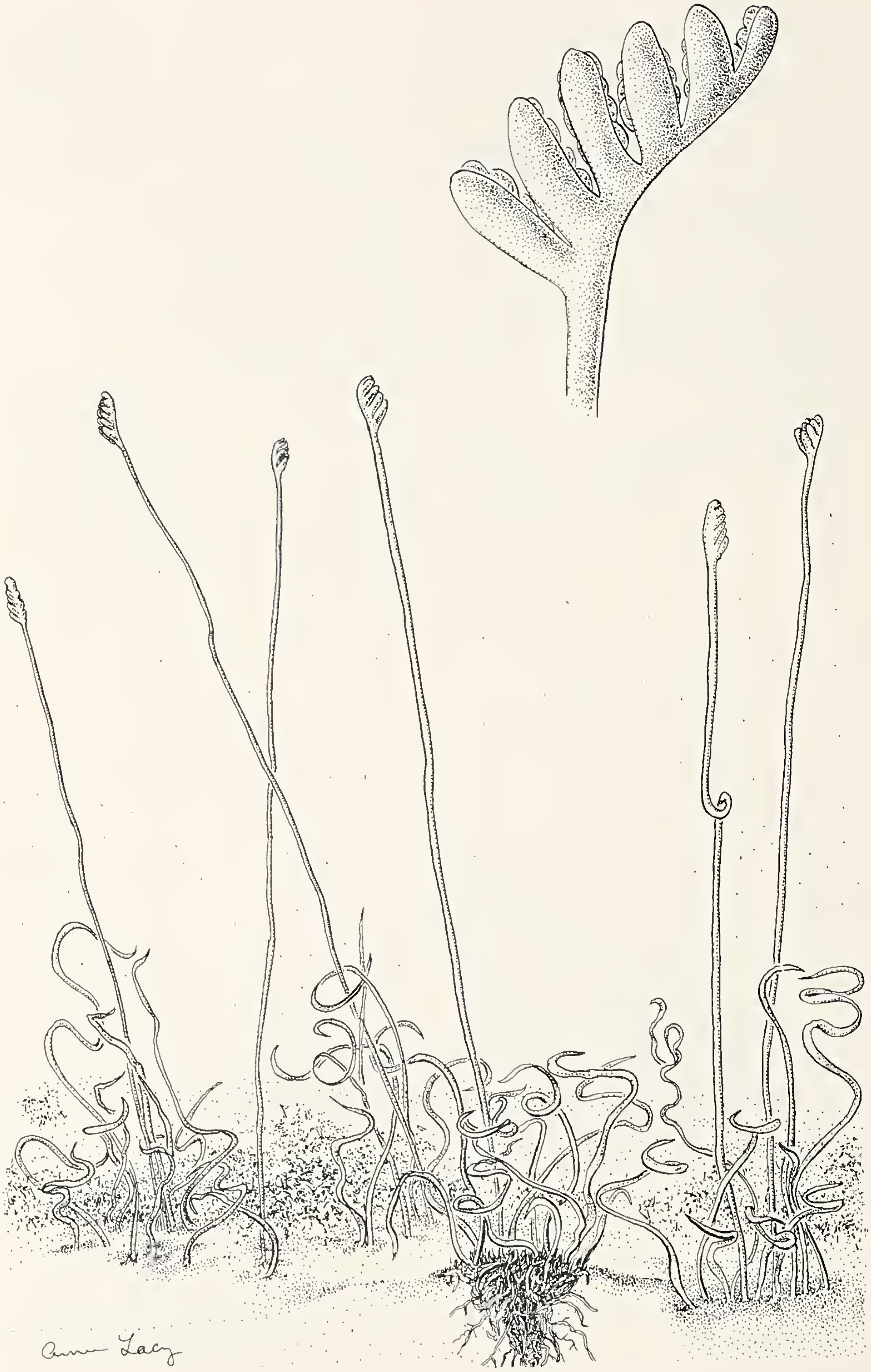
Dryopteris simulata

NY, Vt, NH, Me, Mass, Ct, RI, NJ, Pa.

Swamps, shaded bog margins, moist woods. Soil very acid.

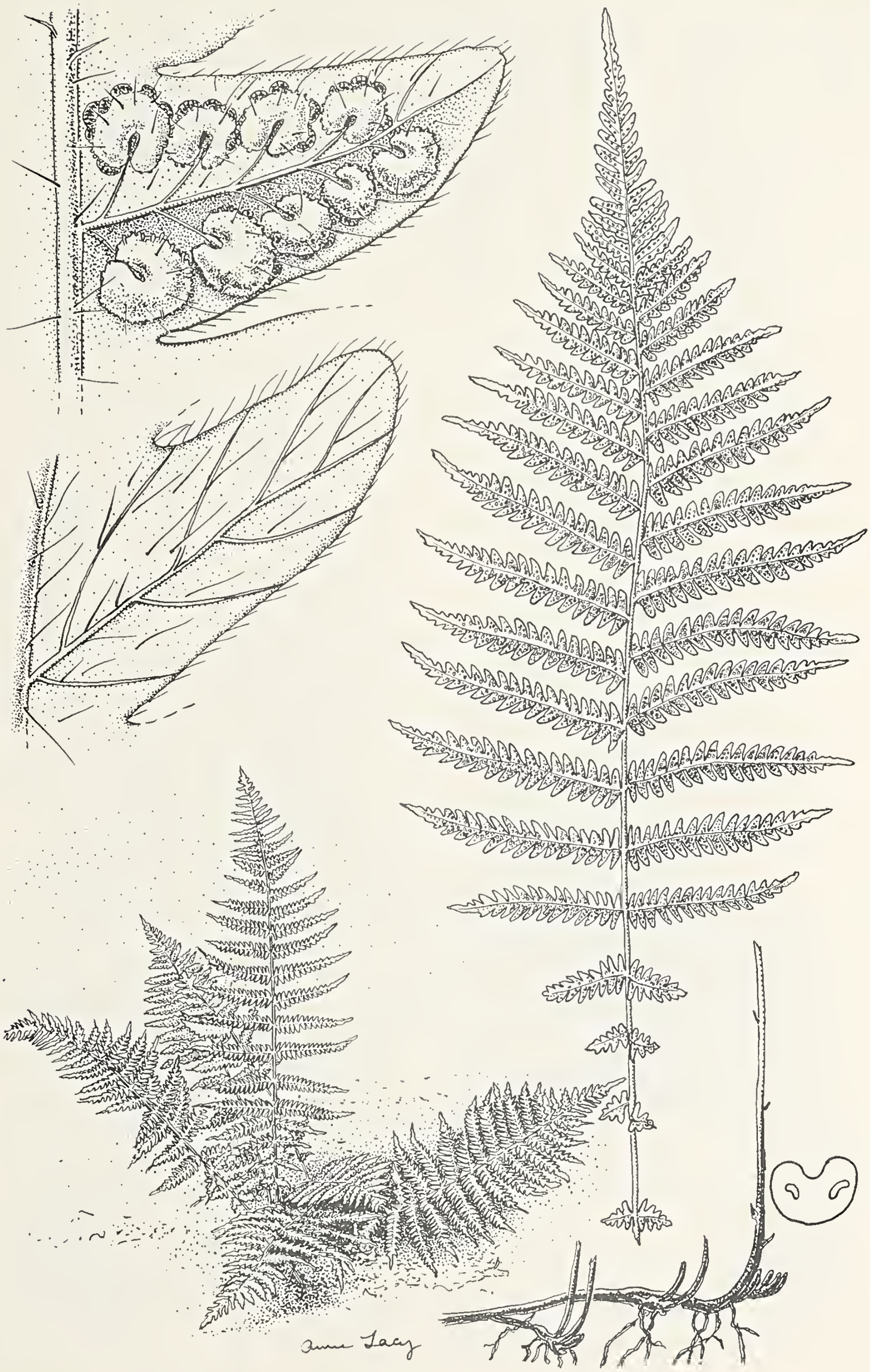
RHIZOMES creeping, branching, 2-3(-4) mm in diameter, glabrous, with a few scales. FRONDS not dimorphic (although fertile fronds are usually longer than sterile fronds), solitary, 35-55 cm long, not evergreen. STIPE about same length as blade, glabrous, without scales or a few at base, with 2 oval or short-linear bundles at base, these united upward to form a curved bundle. BLADES lanceolate, 18-35(-50) cm long, 8-15 cm wide, pinnate-pinnatifid to nearly bipinnate; rachis glabrous on the upper side, with a few hairs on the underside, without scales. PINNAE lanceolate, sessile, lowest pair about same length or a little shorter than middle pinnae. PINNULES (segments) oblong, mostly glabrous but with a few hairs on the veins; margins entire. VEINS free, not forked, reaching the margin. SORI not marginal but often nearer the margin than the midvein, circular, separate. INDUSIA reniform, often circular but with a sinus, persistent, with tiny glands on the margins. SPORES bilateral.

Plate 52



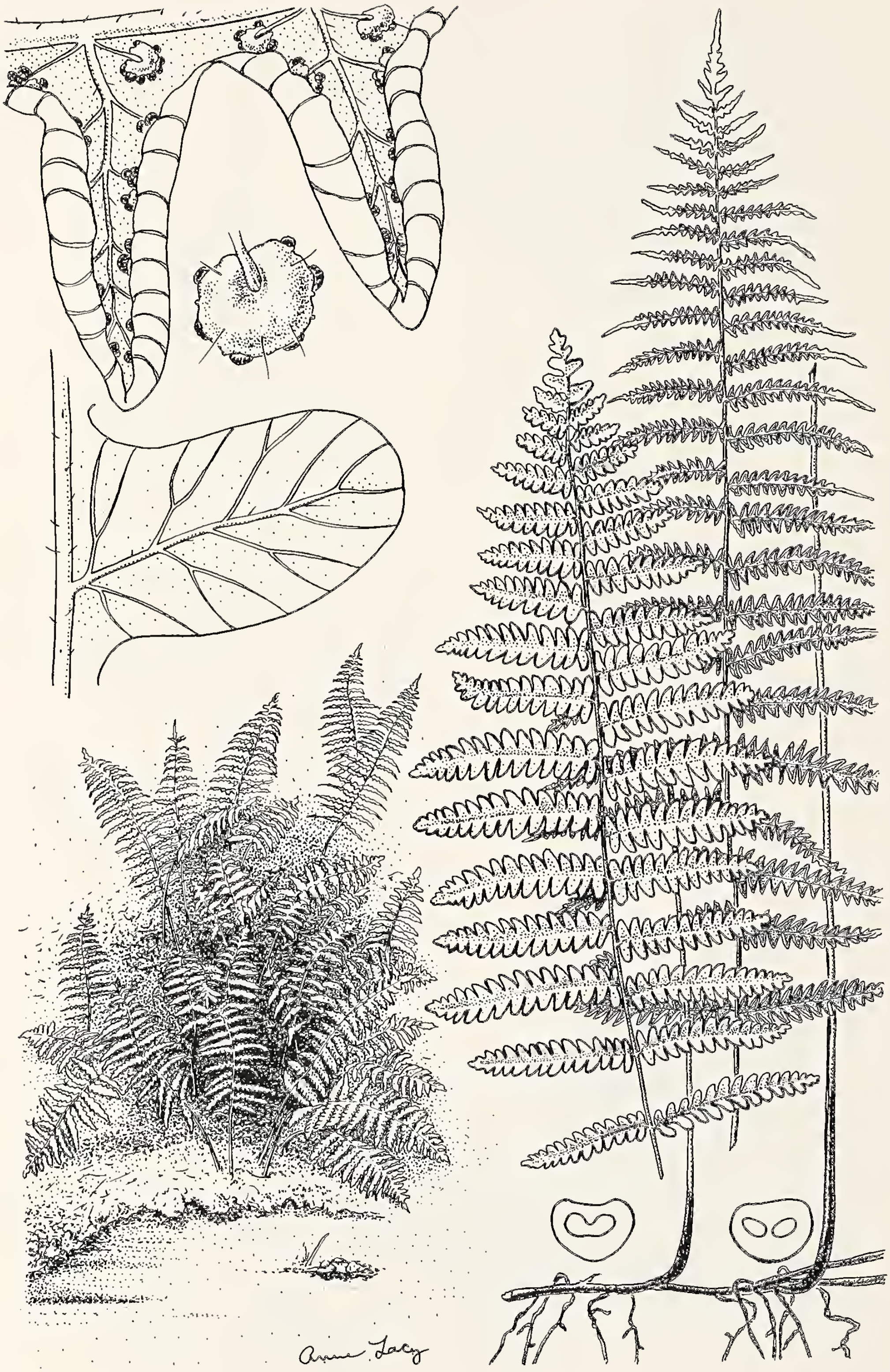
Schizaea pusilla CURLY GRASS

Plate 53



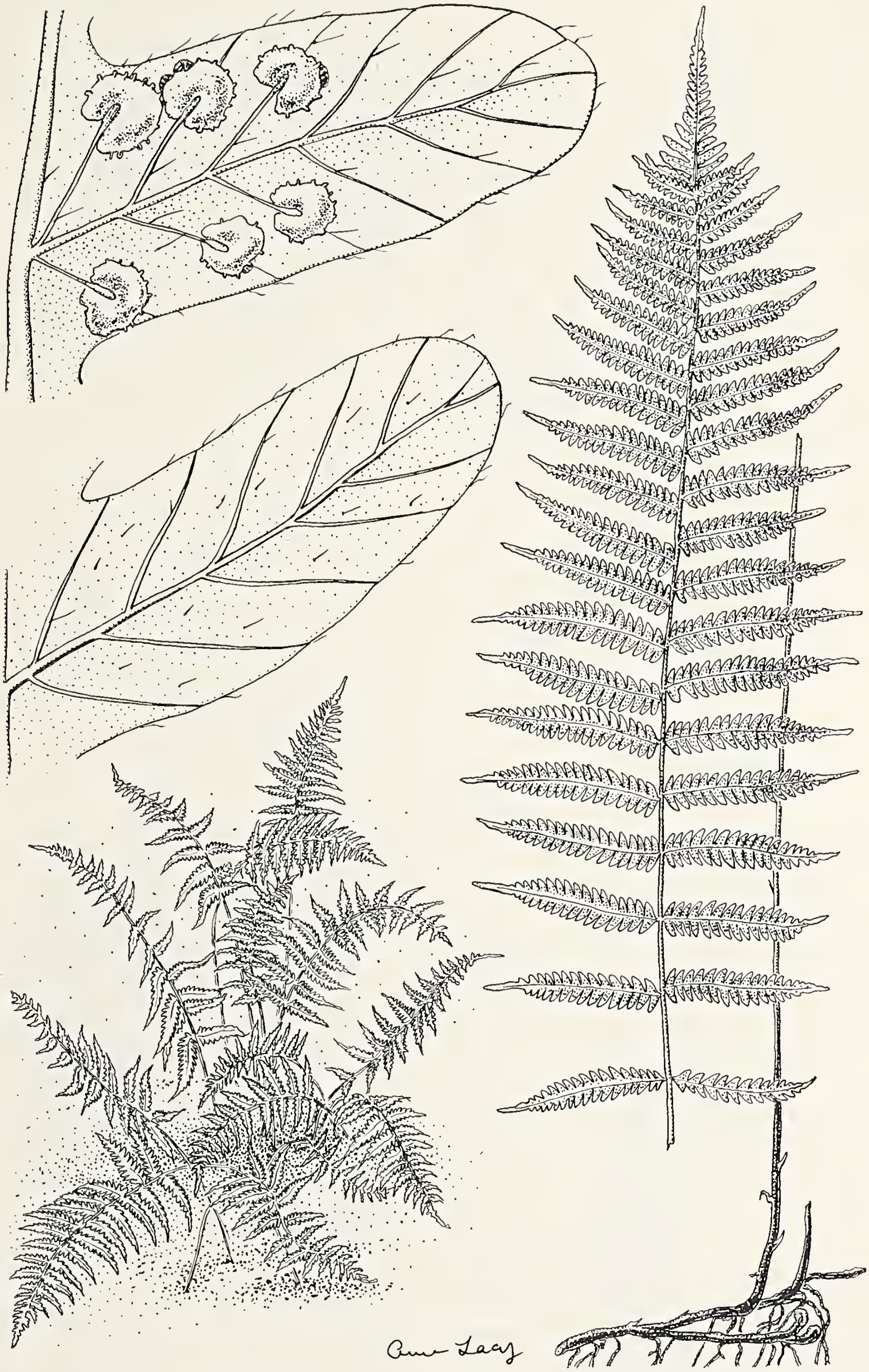
Thelypteris noveboracensis NEW YORK FERN

Plate 54



Thelypteris palustris MARSH FERN

Plate 55



Thelypteris simulata MASSACHUSETTS FERN

Woodsia alpina (Bolton) S. F. Gray Plate 56

ALPINE WOODSIA

NY (rare), Vt (rare), Me (rare).

Crevices in shaded rock at high elevations. Soil calcareous or neutral to slightly acid.

RHIZOMES slender, short, with a few scales and with old stipe bases of nearly equal length. FRONDS not dimorphic, in dense clusters, 6-15(-22) cm long, not evergreen. STIPE shorter than the blade, jointed below the middle, nearly black at base, brown to yellowish or greenish above, shiny, with a few hairs and scales, with 2 circular or oval bundles at base, these united very near the base forming a V-shaped bundle. BLADES linear-lanceolate, (2-)8-15 cm long, (0.5-)1-2.5 cm wide, pinnate-pinnatifid; rachis glabrous or with a few hairs and a few scales. PINNAE 5-18 pairs, ovate, sessile, lowest pair usually shorter than middle pinnae, glabrous on the upper sides, with a few hairs on the undersides, scales few or none; margins entire. VEINS free, forked, mostly not reaching the margin. SORI near the pinna margin, circular, separate or confluent. INDUSIA cuplike when young, soon raylike, being small disks with long, septate hairlike segments. SPORES bilateral.

Woodsia glabella R. Brown Plate 57

SMOOTH WOODSIA

NY (rare), Vt (rare), NH (rare), Me (rare).

Wet, shaded ledges of calcareous rock, mostly at high elevations. Soil neutral or nearly so.

RHIZOMES slender, short, with scales and with old stipe bases of nearly equal length. FRONDS not dimorphic, in small clusters, 5-16 cm long, not evergreen. STIPE shorter than the blade, jointed below the middle, greenish or straw-colored, glabrous, with scales at base only, with 2 circular or oval bundles at base, these united near the base, forming a V-shaped bundle. BLADES linear or linear-lanceolate, 4-8 cm long, 0.6-1.5 cm wide, pinnate-pinnatifid; rachis without hairs or scales. PINNAE 6-23 pairs, nearly circular to triangular, often 3-lobed, sessile, shorter than middle pinnae, glabrous; margins entire or crenate. VEINS free, forked, mostly not reaching the margin. SORI near the margin, circular, separate or confluent with age. INDUSIA cuplike when young, soon raylike, being small disks with septate, hairlike segments. SPORES bilateral.

Woodsia ilvensis (Linnaeus) R. Brown Plate 58

RUSTY WOODSIA, RUSTY CLIFF FERN

NY, Vt, NH, Me, Mass, Ct, RI (rare), NJ, Pa.

Dry exposed cliffs, ledges, rocky slopes, often in full sun. Soil usually acid, pH mostly 5-6, but sometimes nearly neutral.

RHIZOMES short, often branched, with many scales and with old stipe bases of nearly equal length. CROZIERS covered with silvery-white hairs. FRONDS not dimorphic, in dense clusters, 5-25 cm long, not evergreen. STIPE shorter than blade (rarely longer), jointed at or below the middle, dark brown, shiny, with hairs and hair-tipped scales, with 2 circular or oval bundles at base, these united very near the base forming a V-shaped bundle. BLADES oblong-lanceolate, 5-12(-15) cm long, 1-4 cm wide, pinnate-pinnatifid to bipinnate; rachis hairy and scaly. PINNAE (7-)10-16(-23) pairs, ovate-lanceolate, each pinna usually with 4-7 lobes, sessile, lowest pinnae usually slightly shorter than middle pinnae, densely hairy with long rust-brown (whitish when young) hairs, densely scaly; margins shallowly crenate. VEINS free, forked, mostly not reaching the margin. SORI near the margin, usually hidden by the hairs, circular, separate but close and confluent with age. INDUSIA cuplike when young, soon raylike, being small disks surrounded by many hairlike segments. SPORES bilateral.

Woodsia obtusa (Sprengel) Torrey Plate 59

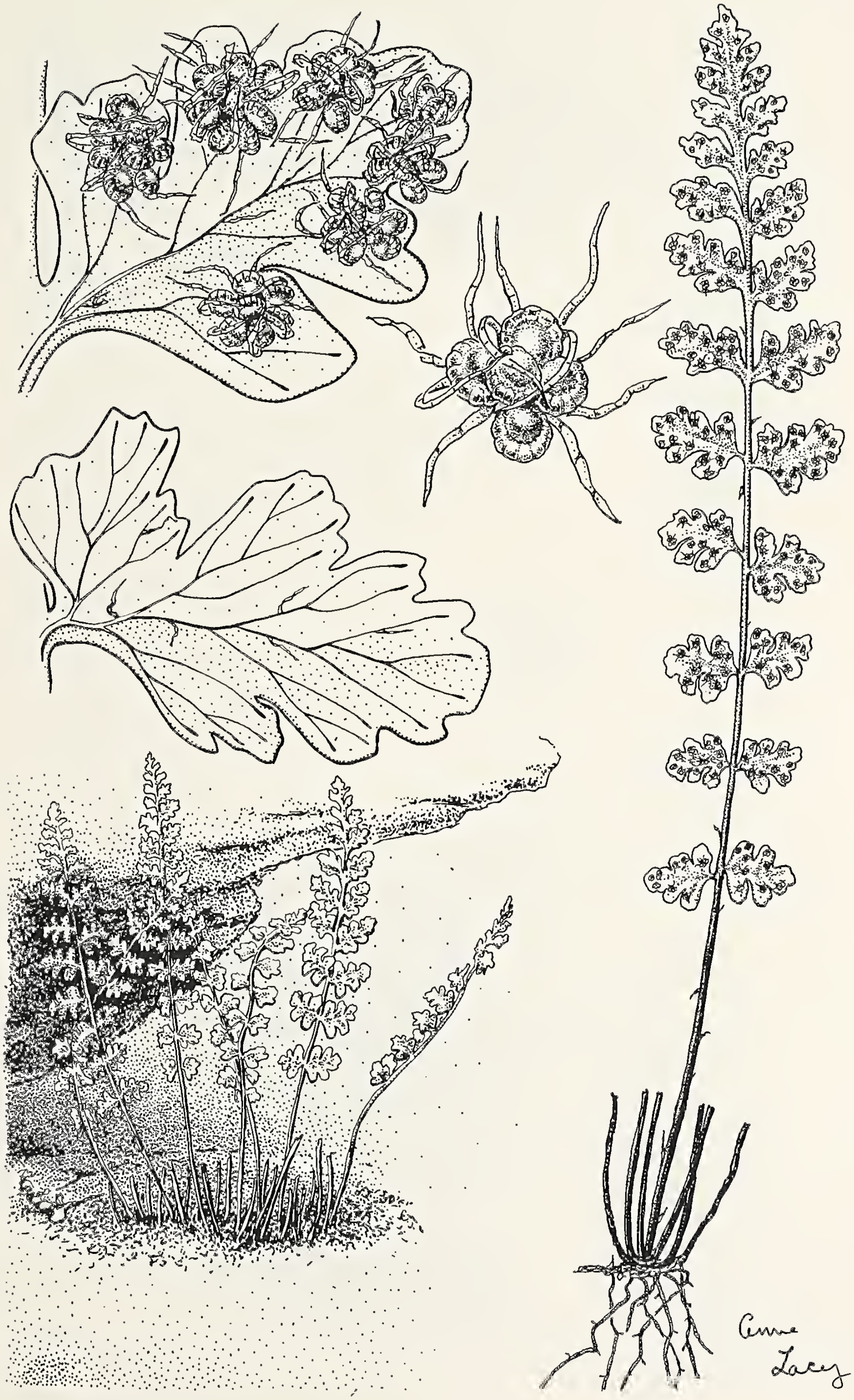
BLUNT-LOBED WOODSIA

NY, Vt, NH, Me (rare), Mass, Ct, RI, NJ, Pa.

Shaded crevices in cliffs, rocky ledges, talus slopes, on cement, sometimes open woods. Soil acid to neutral, pH usually 5-7.

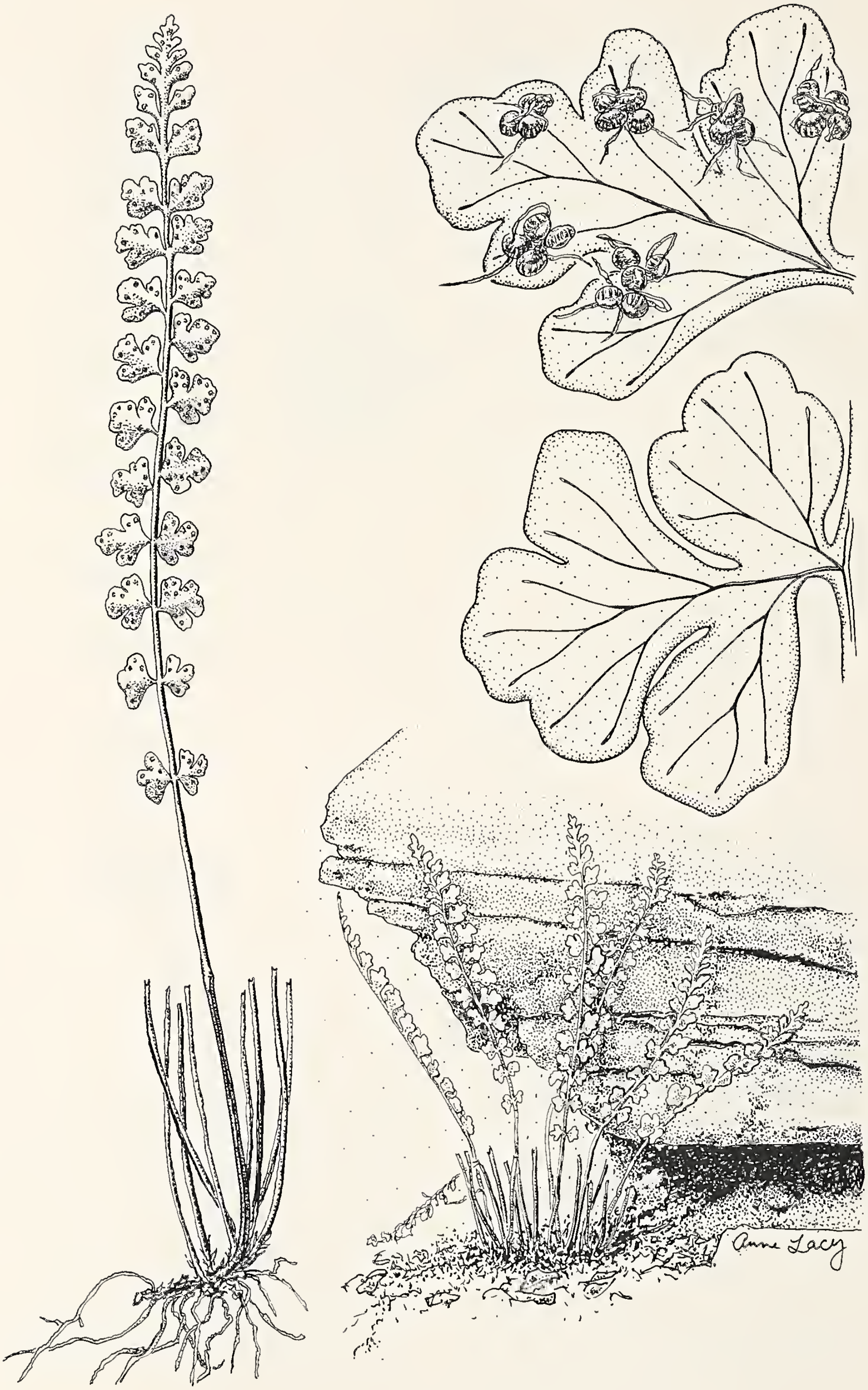
RHIZOMES stout, often branched, with a few brown scales, with stipe bases of unequal length and with persistent old fronds. FRONDS not or slightly dimorphic, in clusters, (10-)25-40(-55) cm long, semi-evergreen. STIPE shorter than the blade, not jointed, dark orange at base, straw-colored or greenish above, hairy and scaly, with 2 circular or oval bundles at base, these united very near the base forming a V-shaped bundle. BLADES lanceolate, 10-25(-40) cm long, (2-)3-10(-15) cm wide, pinnate-bipinnatifid or bipinnate-pinnatifid, greenish when young, becoming yellowish with age; rachis with glandular hairs and a few scales. PINNAE 8-20 pairs, ovate to ovate-lanceolate, sessile or nearly so, lowest pair shorter than middle pinnae. PINNULES 5-9 pairs, oblong, with obtuse lobes, with small white glandular hairs on

Plate 56



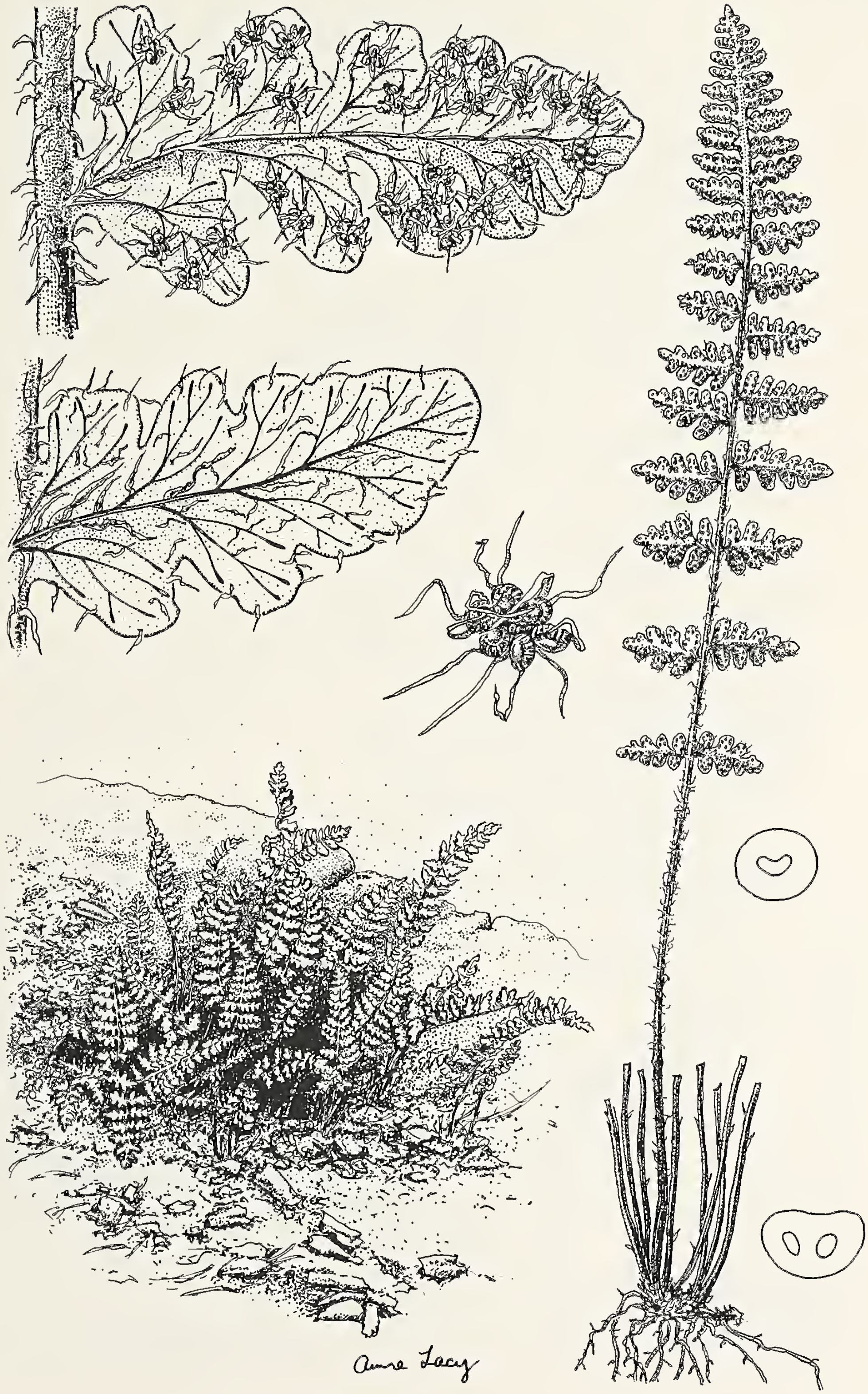
Woodsia alpina ALPINE WOODSIA

Plate 57



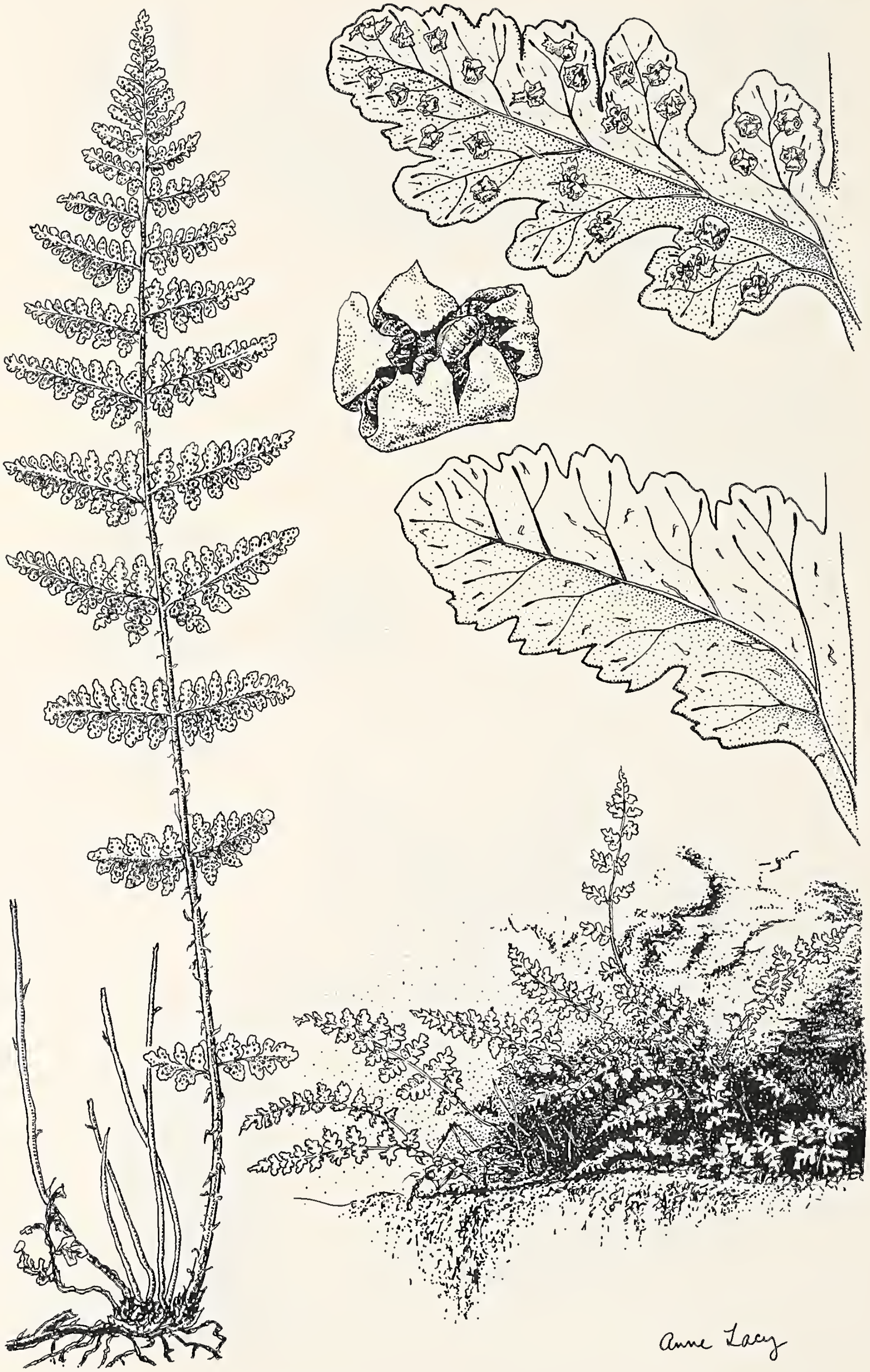
Woodsia glabella SMOOTH WOODSIA

Plate 58



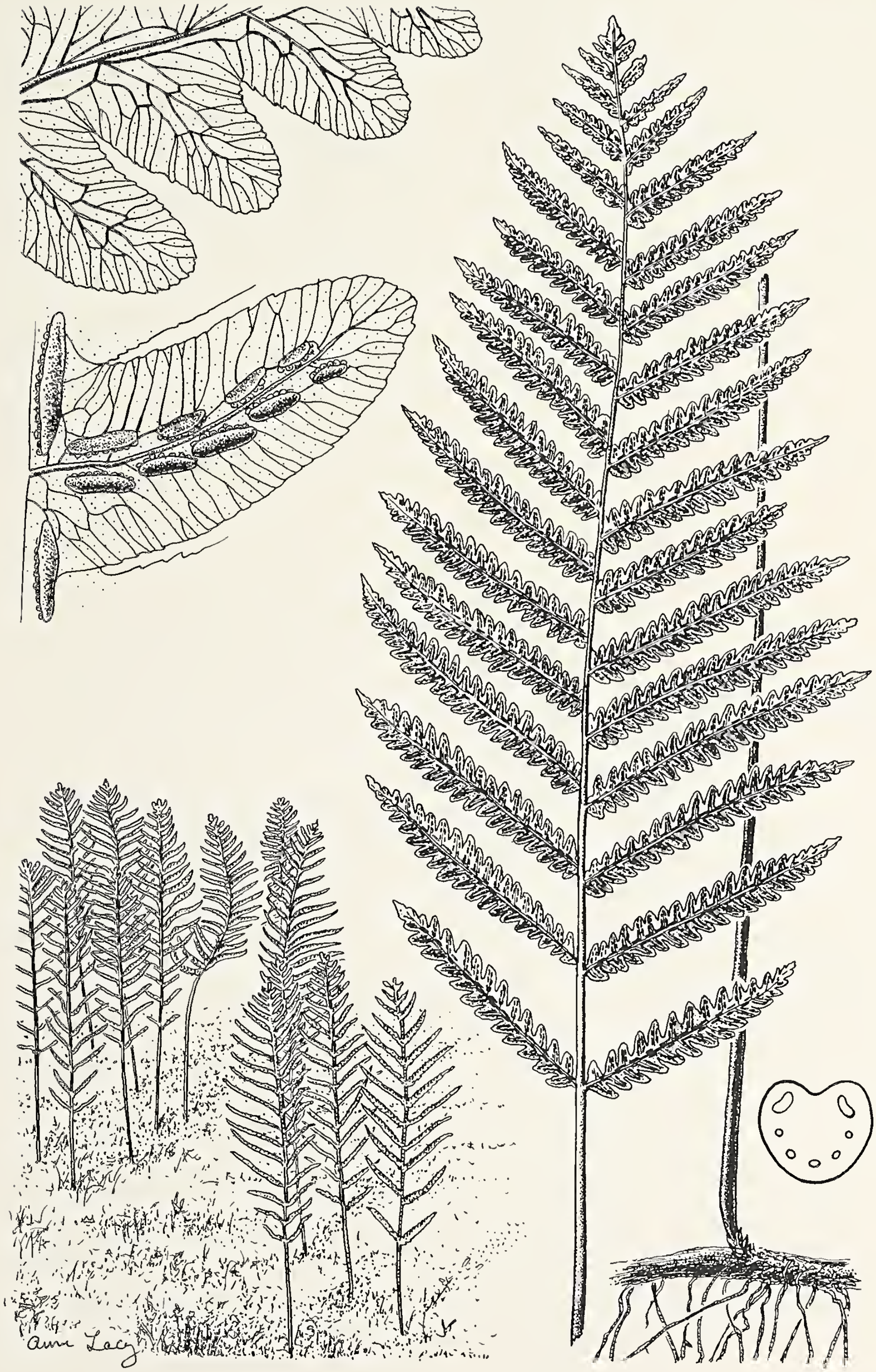
Woodsia ilvensis RUSTY WOODSIA

Plate 59



Woodsia obtusa BLUNT-LOBED WOODSIA

Plate 60



Woodwardia virginica VIRGINIA CHAIN FERN both surfaces, with scales on the veins; margins crenate. VEINS free, forked, mostly not reaching the margin. SORI mostly not near the margin, circular, separate or confluent with age. INDUSIA cuplike when young, soon raylike, being small disks with 3-6 scalelike segments. SPORES bilateral.

Resembles *Cystopteris fragilis* which has no scales on the rachis.

A somewhat similar species, *Woodsia oregana* D. C. Eaton, is represented in our area only by variety *cathcartiana* (Robinson) Morton which is found in our area in but one locality in New York. Among our species of *Woodsia* it would appear most like *W. obtusa* from which it differs by having stipes without hairs and with scales only at base, pinnae with only 2-5 pairs of pinnules, and indusia with long hairlike rays.

Woodwardia virginica (Linnaeus) J. E. Smith
Plate 60

VIRGINIA CHAIN FERN

Anchistea virginica

NY, Vt (rare or extinct), NH, Me, Mass, Ct, RI, NJ, Pa.

Swamps, bogs, often in shallow water, does well in full sun. Soil slightly to very acid or, near the ocean, alkaline or brackish.

RHIZOMES woody, creeping, branching, 5-10(-20) mm in diameter, scaly at tips. CROZIERS without hairs or scales, reddish brown. FRONDS not dimorphic, borne singly from points on the rhizome, 45-140 cm long, not evergreen. STIPE about same length as blade 2-8 mm wide, greenish, reddish or purplish-brown, glabrous, with a few scales at base, with 2 large circular or curved bundles and 3-7 smaller ones. BLADES oblong-lanceolate, 30-80 cm long, 12-30 cm wide, deeply pinnate-pinnatifid to nearly bipinnate; rachis greenish-brown, with short hairs. PINNAE 15-20 pairs, alternate or nearly opposite, ascending, oblong, sessile, the largest mostly 8-15 cm long, 2-3 cm wide, lower pinnae shorter than middle pinnae, segments 15-20 pairs, nearly opposite, oblong, obtuse, 5-15 mm long, 5-6 mm wide, glabrous, usually with a few scales along the midveins; margins firm, nearly entire but with very tiny teeth. VEINS mostly free, forked and reaching the margin, but reticulate along the midvein. SORI not marginal, forming two rows along the midvein, oblong-linear, separate but contiguous, usually 10-12 on each segment and also others along the midvein of the pinna. INDUSIA laterally attached, opening toward the midvein, disappearing with age. SPORES bilateral.

GLOSSARY

The definitions in this glossary are for use with ferns. Some of the terms have a broader meaning or a slightly different meaning in some other publications.

acuminate: tapering to a long slender point.

acute: sharp-pointed; ending in a point less than a right-angle.

alluvial: soil deposited by water, usually rich in organic matter.

alternate: not opposite to each other but attached at different levels.

apex: tip or point.

attenuate: tapering gradually to a long tip.

auricle: an ear-shaped lobe or appendage.

basal: lowest.

bilateral: having two sides that are equal; two-sided; bilateral fern spores appear to be plano-convex.

bipinnate: twice pinnate.

blade: broad expanded portion of a frond.

bundle: group of specialized cells (conducting tubes and fibers) that, in cross section, appear much different from the surrounding tissue; do not confuse with cavities that may be present.

calcareous: soil containing lime; pH above 7.

cm (centimeter): equal to 1/100 of a meter or equal to 10 millimeters; an inch is approximately 2.5 cm long.

ciliate: fringed on the margin with slender hairs.

confluent: running into each other or blending together.

contiguous: adjoining; touching its neighbor.

coriaceous: leathery in texture.

crenate: having rounded teeth.

crenulate: with small rounded teeth.

crozier (or crosier): an uncoiling frond; young, coiled fern frond; fiddlehead.

cuneate: wedge-shaped.

cuplike: attached at the base and surrounding the sorus.

dentate: with teeth, usually directed outward.

denticulate: finely dentate.

dimorphic: of two forms; sterile and fertile blades, or parts of blades, appear much different.

dissected: cut into lobes or divisions.

elliptic: oval or lens-shaped.

entire: margin without teeth; may have large lobes.

evergreen: remains green during winter.

fertile: with spore-bearing structures.

fibrovascular: composed of fiber cells and conducting cells.

fiddlehead: crozier; curled young frond resembling the head of a violin.

free: distinct; separate; veins that are unbranched or forked but whose branches do not unite; not reticulate.

frond: leaf, including stipe and blade or blades.

genus: a closely related group (one or more species).

glabrous: without hairs.

hair: slender, linear outgrowth: it sometimes has a small, spherical, waxy tip.

hastate: arrow-head shape but with basal lobes pointing outward.

herbarium (herbaria): a collection of preserved plants, usually pressed flat, dried, mounted on stiff paper with appropriate labels, and filed for easy access; also the room or building where such plants are stored.

hoodlike: arching over the sorus in bladder-like fashion.

hybrid: result from a cross between unlike organisms.

indusium (indusia): a covering over or around a sorus.

lanceolate: lance-shaped, narrow, tapers to apex, widest below the middle.

linear: longer than wide, with parallel sides; at least twice as long as wide.

lobed: dissection less than half way to the midvein, usually rounded.

lunate: halfmoon or crescent-shaped.

membranous: thin and delicate; usually translucent.

midvein: middle vein of a blade, pinna, pinnule, or segment; midrib.

muricate: surface with small, sharp projections.

neutral: neither acid nor alkaline; with a pH of 7.

node: place on rachis where pinnae are borne; place on rhizome where fronds are borne.

oblong: short-linear, not more than three times as long as wide.

obovate: inverted ovate; egg-shaped, with broader end upward or outward.

opposite: a pair of parts attached at the same level across from each other, such as pinnae attached at the same level on the rachis.

ovate: egg-shaped in outline with the broader end downward or attached to the stalk.

palmate: with divisions radiating from a common center, like the fingers of a hand, may be lobes, pinnae, veins, etc.

peltate: umbrella-like, with a centrally attached stalk.

perispore: a loose covering around a spore which is distinct from the spore wall; sometimes called epispore.

pinna (pinnae): primary division of a dissected blade cut to the rachis; it may be undivided or divided one or more times.

pinnate: blade dissected all the way to the rachis, but the pinnae not further dissected half way to the midvein.

pinnatifid: blade or parts of blade dissected more than half way, but not all the way, to the rachis or to the midvein.

pinnule: secondary division of a blade cut to a secondary rachis or midvein.

plano-convex: plane (nearly flat) on one side and convex (rounded outward) on the other; spores of this shape are bilateral.

rachis: midvein of a dissected blade; continuation from the top of the stipe at the base of the blade through the blade to its apex.

random access: process for obtaining information in any order from a storage system; a random access key allows the user to choose any stored character in any order.

raylike: radiating from a center; a raylike indusium is similar to cuplike but splitting into broad or slender structures.

reflexed: turned or curled downward, outward, or backward.

reniform: kidney-shaped; similar to peltate but with a notch or sinus.

reticulate: like a network; anastomosing; veins that join again after dividing.

rhizome: underground stem.

scale: broad, flattened outgrowth; similar to hair but broader at base and usually of firmer texture.

segment: the smallest division (except lobe or tooth) of a dissected blade; the dissection extends more than halfway, but not all the way to the midvein.

serrate: sharp, sawlike teeth pointing toward the apex.

serrulate: finely serrate.

sessile: without a stalk at point of attachment.

simple: not branched.

sinus: cut or notch between two lobes.

sorus (sori): cluster of sporangia; area where spores are formed.

species: a group of closely related, mutually fertile individuals, sharing the same characteristics.

spinulose: with small spines or bristle-tipped teeth.

sporangium (sporangia): container in which spores are produced.

spore: tiny single-celled reproductive body (asexually produced).

sporocarp: organ containing spores or sporangia.

sterile: frond or blade lacking sori.

stipe: petiole or stalk of the frond, from rhizome to base of blade.

succulent: fleshy or juicy.

taxon (taxa): a taxonomic group; refers to an unspecified category, such as genus, species, variety, etc.

teeth: projections on the margins, usually with pointed apices, indented less than ¼ of the distance to the midvein.

ternate: divided into three nearly equal parts.

tetrahedral: having four sides; tetrahedral fern spores appear to be circular or nearly so.

tripinnate: blade three times dissected, forming pinnae, pinnules, and pinnulets.

triplanate: having three sides; triplanate fern spores appear to be triangular or circular.

vein: a strand of conducting tissue; it may be branched or unbranched.

venation: arrangement of veins in a blade.

winged: a border of thin, flat tissue as on the rachis of some ferns.

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Rare Plants of New York State

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RARE PLANTS
OF
NEW YORK STATE

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1981

Bulletin No. 445
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The State Education Department
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AND SOME THAT DIE DESERVE LIFE.
CAN YOU GIVE IT TO THEM?
THEN BE NOT TOO EAGER
TO DEAL OUT DEATH . . .
EVEN THE WISE CAN NOT SEE
ALL ENDS."

J.R.R. Tolkien

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FOREWORD

THROUGH THIS PUBLICATION we seek to reach the interested public as well as professionals in conservation and biology. The book is not intended to be a purely technical botanical document, but a practical guide and introduction to the subject of rare plants in the State. We have chosen to exclude literature citations and other materials which make reading difficult. The glossary will hopefully serve to clear up meanings of botanical terms and technical uses of common words.

IF YOU FIND A RARE PLANT . . .

If you know the locality of a rare plant population of which this agency may not have been informed, please notify:
Office of the State Botanist
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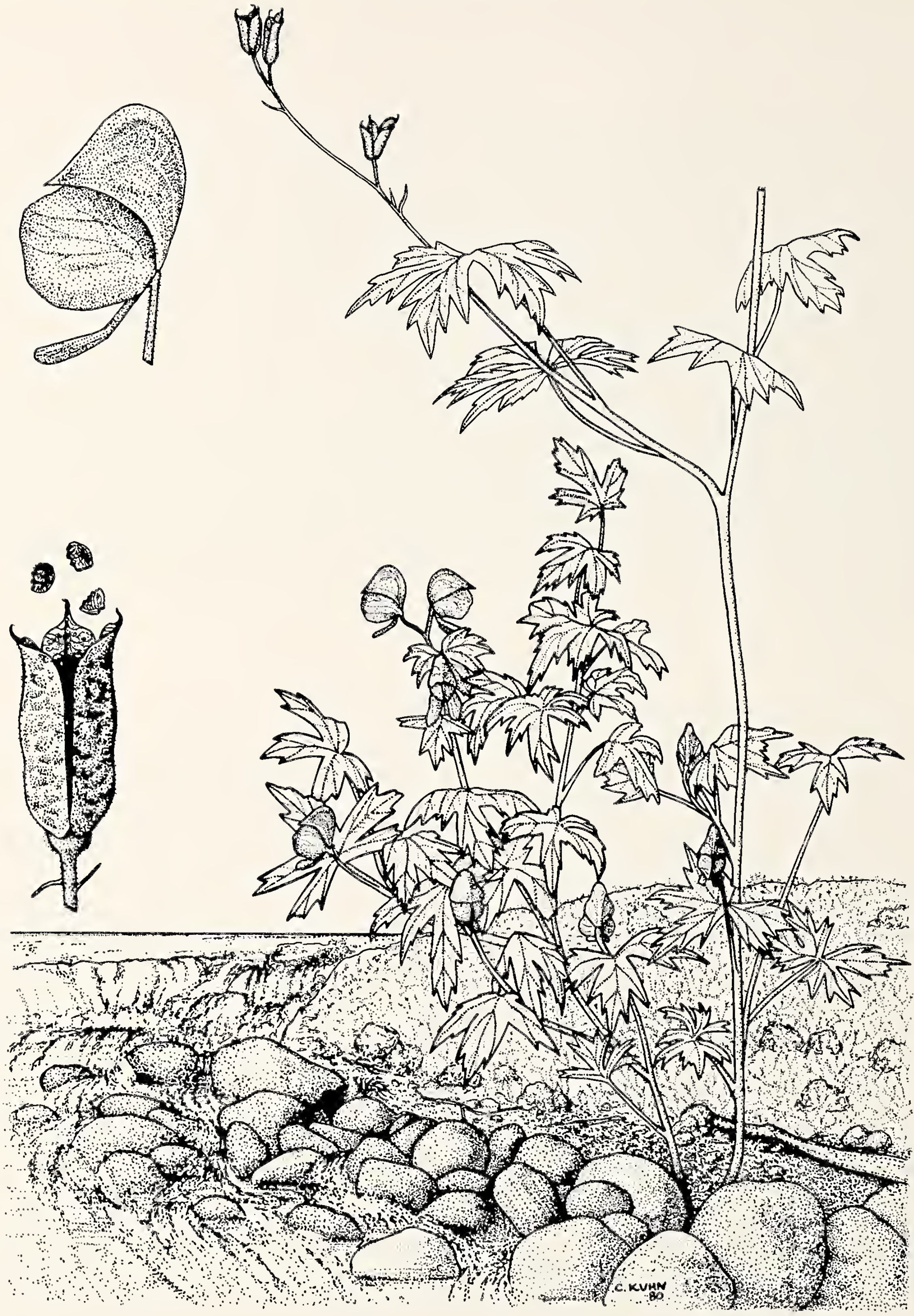
PREFACE

Over the past century, rapid industrial expansion, agriculture and increased housing needs have put considerable stress on natural plant communities. The importance of green plant associations must not be underestimated, since they provide the oxygen we breath and are sources of timber, energy, food, new medicines, and cultivated plants of the future. They alone can build soils and provide shelter for wildlife. Fragile biological communities stand at the very foundation of man's well-being, and these are able to thrive only if they remain diverse in numbers and kinds of plants and animals. Civilization has tended to promote the success of weedy, scrubby, and noxious plants, while eliminating the beautiful, the useful, and the rare from nature. This is not necessary. There are vast expanses of land the world over which can be cleared, burned, and further developed without measurable harm. In most cases, destruction of critical habitats is not intentional, but merely convenient or arbitrary, and might be avoided through cooperation between scientists, agencies, private owners and businessmen. It is also up to responsible biologists to identify endangered species and habitats and to alert potential developers to avoid their locations. Although conflicts will surely arise where profits are to be made, good information exchange in early planning stages can lead to proper land use without high costs. It is important for all of us to understand the economic and aesthetic reasons for preserving the diversity of plant and animal life in our State. This publication is dedicated to all those New York State citizens and visitors who believe that progress and prosperity may best be achieved without further destruction of unique wild places.

ACKNOWLEDGMENTS

We are particularly grateful to our colleague J. Kenneth Dean who worked with us throughout the intensive phases of this work. He has been a tireless field companion and excellent observer, from the top of Mt. Marey to the tip of Montauk—from Buffalo to Barkaboom (so to speak). We wish to acknowledge the work of our predecessors at the New York Museum and their 140-year tradition of interest in the rarities of the State, beginning with Governor Marcy and John Torrey. Location of some of our rare plants would not be possible were it not for distribution-map files begun by Homer D. House over 65 years ago and kept current by Stanley J. Smith for some 30 years. Documentation of the present status of rarities was accelerated during the period of 1978–80, under contract with the U.S. Fish and Wildlife Service. We especially wish to thank Richard Dyer of their Endangered Species Office (Region 5) for his advice, administrative time and cooperation with us during the project. We are grateful to Winthrop Aldrich, James Beil and Elizabeth Wald of the State Department of Environmental Conservation for cooperation in many matters. Special thanks go out to all of our cooperators and participating botanists who number in the hundreds and cannot be listed here. Notable among the people who have put special effort into helping us in the field are: Mildred Faust, Orra Phelps, Babette Coleman Brown, George Nevin, Shirley Nevin, Robert Clausen, Betty Lotowycz, Bruce Gilman, Steven Eaton, David Hammond, Tim Barnett, Richard Zander, Bill Countryman and Karl Brooks. Deserving special mention are the two field botanists hired by The Nature Conservatory to study plant rarities in northern New York State. Tom Carrolan (1979) and Elizabeth Yanuck Platt (1980) both provided excellent information as a result of plant exploration in the Adirondacks and identification of significant habitats in need of protection. Finally, we would like to express our special appreciation to the more than 60 persons who attended our rare plant workshop in November 1979. The discussions and contributions of participants gave us many new insights and helped immeasurably in refining the State's rare plant list.



NORTHERN MONK'S-HOOD *Aconitum noveboracense.* These rare and beautiful plants were the first in New York State to be protected by federal law. The species, which derives its latin name from its discovery in New York, is known from fewer than 20 locations in the world. Illustrated here are fall plants which have fruited from July-August flowers and continue to flower after deer browse.

Introduction

NEW YORK STATE is a beautiful and diverse mosaic of habitats for animals, plants and man. It boasts the Adirondack and Catskill Mountains as well as the spectacular Hudson Highlands, and is rich in white-water rivers, trout streams and lakes. Two of the Great Lakes border New York State on the north and west, and the lower Hudson River represents a 150-mile tidal estuary. As a result of history, the State has a significant coastline on Long Island and deep-water ports at the mouth of the Hudson River. Limestone contact zones are frequent up the Hudson and along the Mohawk Valley to Lake Ontario, whose eastern shores form significant expanses of flatrock and natural limestone pavement. To the south, the glacially scoured Allegheny Plateau is cut by deep ravines and liberally supplied with waterfalls and finger-lakes.

As glaciers retreated some 15–16 thousand years ago, plants and animals began to invade the lands again. With such an abundance of habitats to populate, there is little wonder that a large variety of the survivors of that cool, wet (pluvial) period found niches in which to grow. Since the glaciers reached their southern limits on northern Long Island and in Cattaraugus County in western New York, it is likely that well-established forests were never far from the State's present borders. The re-vegetation of glaciated land, which continues even today, has been partly a matter of chance dispersal of seeds. Many plant distribution patterns are not easily explained, especially those of rarities; however, there are general consistencies in the relationships between plant growth-forms and succession onto barren lands.

We know that many species of plants from the Appalachians are hardy in cultivation north of the glacial terminus, and these may even invade our fields and forests to become naturalized. Invasion by these species might (or might not) have occurred in time without the intervention of man, but their success brings to mind the possibility, indeed the probability, that our flora is a young one, rich as it is. Given more thousands of years without glaciation, the flora of New York State will likely increase. This could happen through natural migration of southern and western species which would appear as rare species, then expand their ranges. Present rarities in our State are often of this immigrant type, barely hanging on to life in recently found suitable environments. Whether we choose to preserve their chance to survive and contribute to the richness of our heritage will reflect current generations' attitudes toward the natural world, and will inevitably affect the quality of life for all future dwellers in the State.

Extinction

When the last member of a species is lost or incapable of reproduction, that species and its genetic line are truly extinct. Rarity and extirpation are steps on the road to extinction. Extinction is not usually the result of competition within or between species. Until the advent of man, most extinction on land resulted from changes in climate and in the earth's crust. Today the wholesale destruction of tropical rainforest, for instance, brings permanent loss of species each day.

Extirpation

When a species is eliminated from a given area or ecosystem, it is said to be extirpated there. Extirpation has the effect of eliminating special individuals whose peculiarities might be the key to survival of the species when conditions change.

Rarity

The term rarity has a number of different interpretations and shades of meaning, some of which may be incorrectly applied. A species may be found only as scattered individuals, occurring here and there over a broad range. This is not the type of rarity to be discussed here. As used in this publication, rarity means the presence of few or widely scattered populations with regard to a given geographic area. One type of rare plant population, called a disjunct, is separated from the range of the rest of the species. This may be the result of recent long-range dispersal into new territory (an outlier) or the population may be a relict, left behind from a time when the species was more widespread. A species which is found only within a restricted geographic area is called an endemic. Endemic rarities are often known from islands, deserts and along disturbed coastlines, but are far less common in boreal and mixed hardwood forests, such as those of New York State.

This publication will treat in detail selected species of both State and national interest as well as some which are significantly disjunct in New York State. A provincial list of State rarities is included (Appendix II) to focus upon the need to preserve diversity, regardless of the distributions of species outside our State borders.

Causes of Rarity

Attempts to account for rarity lead the investigator from one enigma to another. There are so many reasons why a plant will not (or does not) grow in a given habitat, that it becomes more fruitful to discuss why each species occurs where it does. This may be equally frustrating, since studies combining ecology and physiology are still in their infancy. The following considerations relate directly to presence or absence of a species at a location:

DISPERSAL

Absence of a species from an apparently suitable habitat may be due to chance lack of dispersal of seeds or spores into the area. This is less likely with spores, since they are windborne and are produced in great numbers. Some seeds are wind-distributed, but many require special dispersal agents such as birds and mammals.

ESTABLISHMENT AND SEEDLING SUCCESS

Seeds and spores have different lifespans, depending upon the species. Conditions must be right in a given habitat to meet the dormancy, light, moisture, temperature and other requirements of a seed, or dispersal to that location is not significant. After germination, young plants are immediately in competition with other organisms for light, space, water and nutrients. The numbers and kinds of competitors in the vicinity of a seedling may profoundly alter its survival potential or even eliminate it in an otherwise suitable location. Many kinds of seedlings must establish a relationship (mycorrhiza) between their roots and special soil fungi in order to function efficiently. Absence of the symbiotic fungus can mean seedling death. Some parasitic fungi infect seedlings, causing "damping-off" and other fatal diseases. Browsing mammals, slugs and plant-eating insects offer additional threats.

COMPETITION

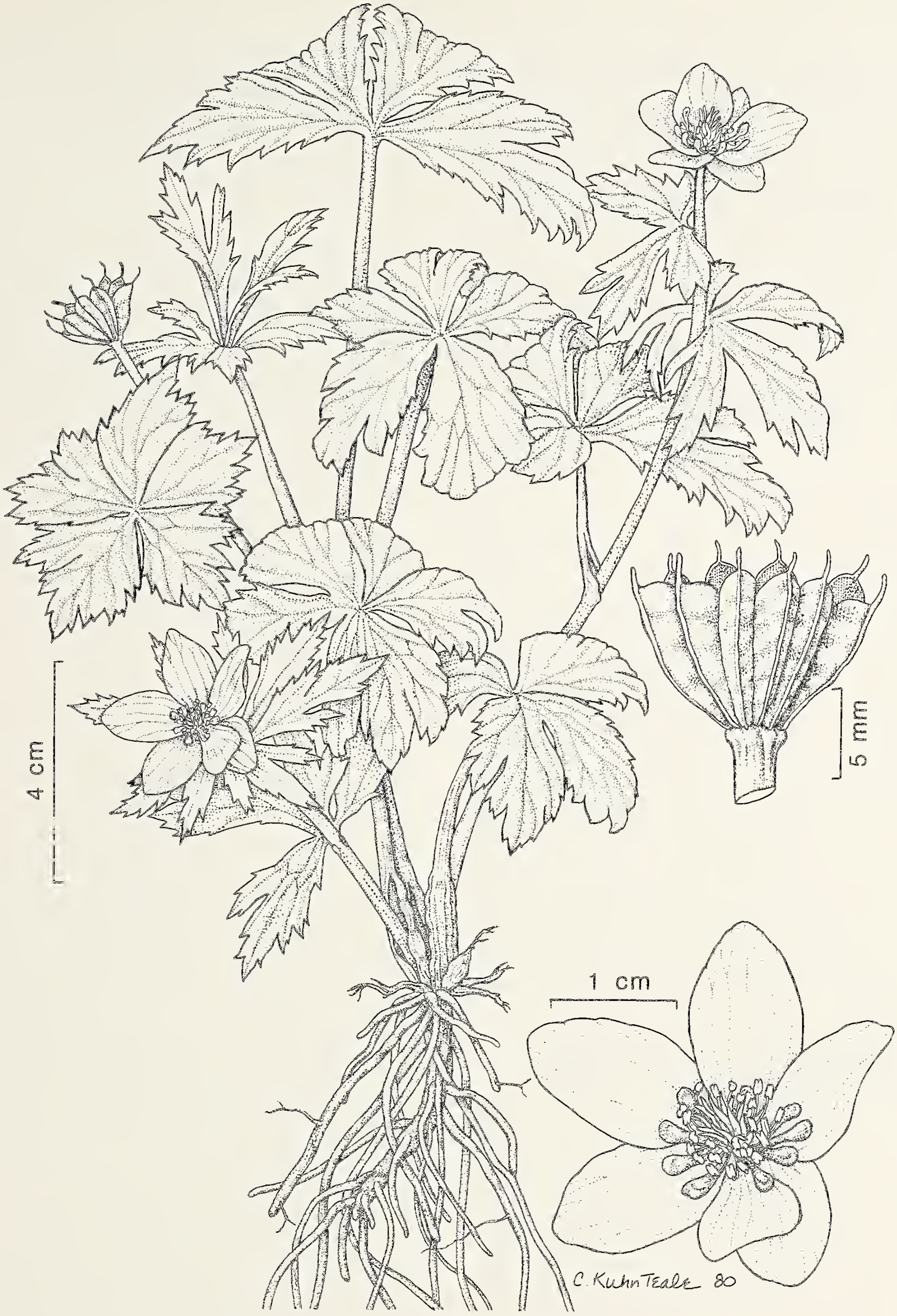
The term competition refers to the interaction of two or more organisms with similar growth requirements and needs for the same environmental resources. Though seedlings are most critically affected, plants are subjected to some sort of competition throughout their lifespans. The effects are negative by definition, and, if the needs of two species are extremely similar, one or the other will die out wherever they come in contact. Thus, a rare plant may be rare because it has been outcompeted by members of another species with similar needs; conversely a rare plant species may never have spread from the habitat in which it evolved, due to its inability to compete with established species. Given two competing species with the same needs, it may easily be seen that a single factor could tip the scale of advantage toward either. High copper content in soil might throw the advantage heavily toward a copper-tolerant, rare species. It would be incorrect of the observer to infer that this rare plant has copper-rich soil as its "preferred habitat". It merely survives there under conditions of reduced competition.

ADAPTATION

Seedlings of most species vary in their inherited characteristics and in their capabilities for surviving in various habitats. If a species produces many potential kinds of individuals with slightly differing needs and tolerances, it is said to be heterozygous, and has the potential to be widespread. Likewise, if most of the seedlings of a species are tolerant to a broad range of conditions, the species is said to be plastic, and also has good chance to be common. Rare plants are often lacking in significant differences between individuals (homozygous) and are not strongly plastic, though there are notable exceptions. Rarities frequently require rather specific habitats and have narrow ranges of environmental tolerance. This is particularly true of flowering plants and less so for conifers and their relatives. The ancient evolutionary lines are not necessarily depleted by lack of adaptability. The Maidenhair Tree (*Ginkgo biloba*) is an example of an ancient type of tree which is tolerant of a wide variety of conditions, including severe pollution. After 400 million years on this planet, during which it occurred on every continent, this tree became so rare that it is believed to have been saved only through cultivation by oriental priests. Today it thrives on city streets in almost any climate where it is planted.

REPRODUCTION

Plants which are rare may be so because of hindrance to their reproductive processes, especially if they evolved under conditions different from those which they now experience. Pollination mechansims are varied, involving wind, water, insects, etc., and these can be crucial in establishment or survival of young or threatened populations. Some plant species are so closely tied to their specific insect pollinators that absence of the insects prevents reproduction by



GLOBEFLOWER *Trollius laxus* ssp. *laxus*. New York State is the only place where this yellow-flowered eastern subspecies is known to occur in numbers. One population of about 2,000 plants is known from the central part of the State, but this is exceptional. Usually a few plants seed into marly wet areas and are soon overgrown by swampforest.

seeds. This can be fatal in the case of annuals, which may not survive if they fail to set seed for a few years. Certain tropical ferns (like *Vittaria*) are known to occur in the Appalachian Mountains, but they do not develop fronds from their tiny, moss-like sexual stages; consequently they have only recently been discovered. This is a reminder that dispersal and establishment are not enough to insure success if conditions are not right for reproduction.

Vegetative reproduction is one way in which a rare plant can survive a hostile environment where it eventually might become adapted and reproduce sexually. Seed production without fertilization (apomixis) is known in some plant groups. Also, propagation by lateral growth or fragmenting (cloning) may favor better adapted individuals while others are dying out.

SUBSTRATE

Soils and exposed bedrock which serve as anchorage for plants also provide much of their moisture and nutrients. Acidity or alkalinity (pH) and a number of complex soil features involved in the exchange of ions make the number of possibilities for potential substrates very high. The sorting out of patterns of species on the land is the result of continuous interaction of soil factors, climate and individual plants. As stated above, some rare plants are found on exotic substrates. Their capabilities for tolerating unusual conditions in the soil have meant their advantage over less tolerant, common plants. Some species found only on serpentine soils are susceptible to damping-off fungi when grown on other soils, but such restriction of species to special soils is rare. Botanical gardens, attempting to create limestone gardens, have often found that plants brought in from calcareous areas escape readily to noncalcareous soils when there is little competition from other species.

CLIMATE AND MICROCLIMATE

Many features of climate, such as mean seasonal temperatures, maximum and minimum temperatures, frost dates, rainfall, prevailing winds, relative humidity and others, profoundly affect the distribution of plants and play a major role in the destinies of species. Restriction of distribution of plants by climate is difficult to assess, but not hard to understand intuitively. Within any climatic zone there is an intricate web of smaller microclimates, defined by such local limits as: wettest-driest, warmest-coldest, etc., with various combinations inbetween. Extreme microclimates in a given forest can simulate desert or tropics, or even arctic tundra, and likewise support species from those varied habitats if they should come in. Then why do we not find bizarre rarities from Africa and Alaska in New York, occupying these niches which might currently support them? Dispersal is the first obvious barrier with seed plants. It is not a serious barrier with spore-reproduced plants such as ferns and mosses. In sporebearing plants a single species may be scattered in similar climatic zones around the world. Other factors are cyclic fluctuations of climatic conditions, and the evolution of new climates over continents as their surface features change. During a major climatic cooling cycle, the warmest, dryest microclimate in an area will probably exceed the tolerance limits of its desert-adapted inhabitants, eliminating them with moisture and cold; plants of extreme cold/moist microclimates will likewise be eliminated during warm/dry cycles. Thus, at any given time there will be extreme microclimates which do not support a flora reflecting their severity. Often such places are relatively bare. Rare plants may disperse from their restricted ranges into open spaces of this type. Where this has occurred, persistence of the colony is again threatened by inevitable climatic fluctuations. Repeated establishment and natural extirpation in such places must go on constantly, expanding and contracting the ranges of species.

Over great periods of time, mountain ranges rise and erode, and drainage patterns change across the continents, altering local climates through the configuration of the land. Where rainfall is low, as in the southwestern United States, north-south trending mountain ranges have profound effects upon climate, precipitating out moisture on their western slopes, leaving deserts in their eastern rainshadows. Such effects are less pronounced in the east, but they still change patterning and survival of plant and animal populations. Nearly everyone who has walked through a northern forest has noticed the greater abundance of mosses on the north side of tree trunks. Though it is not a hard and fast rule, this effect is produced by drying from the sun (detrimental to mosses) to which southern surfaces are more often exposed. Many effects and countereffects of far greater subtlety are continuously being produced—their complex interactions determining the ever-changing distribution of plants.

NEWLY EVOLVED RARITIES

Rarity may in some cases be attributed to the recent origin of the species involved. Two possible examples of this are New England Violet (*Viola novae-angliae* and Houghton's Goldenrod (*Solidago houghtonii*). Both species are known only from recently glaciated lands and have probably evolved in the last 15 thousand years. Houghton's Goldenrod has arisen through hybridization with a subsequent increase in the number of chromosomes. Indeed, New York plants probably arose separately from those in Michigan and Canada, and may represent a new species, endemic to western New York. Sites containing such rarities may be considered natural "evolution laboratories", and should receive protection as such.

CHANCE

The chance that conditions will remain stable at any location for a long period of time is extremely small. Earth history has been characterized by both gradual and violent changes in recent as well as ancient times, and such processes will surely continue in the future. Plants which do not adapt to change or do not continually disperse into favorable conditions are doomed to severe range restriction and extinction as a result of chance events.

MAN'S INTERVENTION

The human species is largely a product of the Pleistocene, a period of catastrophic climatic fluctuation. Over a period of one to two million years, the earth repeatedly cooled and warmed; glaciers spread over vast areas, contracted and receded, only to form again. Forests shrank and were replaced by grasslands and deserts. It was a period during which only the most adaptable could survive. Man's developing mental capacity, stimulated by the challenges presented by Pleistocene environments, dramatically increased his adaptability, setting him apart as the species most able to alter environments to his own needs. The use of his opposable thumb and the extension of his arm and grip through the invention of tools gave man a striking competitive advantage, and allowed the spread of the species from its African birthplace to cover, and in many ways conquer, the earth's surface.

Sometime during the last major glacial stage (Wisconsinan), bands of hunters crossed into Alaska from Asia. Their descendents pressed southward and eastward, hunting the remaining great ice-age mammals as well as smaller game. Recently it has been proposed that the hunting pressure from these early North Americans was enough to cause extinction of the great Pleistocene mammals. This theory is sharply debated, but if it is correct for even a single species it means that extinction at the hands of man began on this continent thousands of years ago.

By the time Europeans discovered the Americas, the American Indians—ultimate descendants of the original Asian immigrants—had thoroughly occupied North America and established a successful equilibrium with the fauna and flora in most places. Under conditions of primitive technology, low population levels and some migration, Native Americans had little more impact than natural predators. That is not to suggest that they did not affect the biota, especially at the local level. Over some extensive areas burning regimes altered vegetation and maintained fire-climax associations of plants and animals. Disturbance attendant with camp life and agricultural practices provided niches for rare species as well as promoting the development of "camp-following" native weeds.

With European settlement, the face of the land began to change drastically. Europeans, rooted in an agricultural heritage and coming from manicured and orderly landscapes, arrived on the North American continent with a strong will to alter the wilderness. Despite initial hardship and drawbacks, they began a steady conversion of natural vegetation areas to farmlands and yards. Even today, with increased environmental awareness, there is the prevailing attitude among North Americans that progress is inescapably linked with destruction of wild places. This amounts to a serious prejudice against our national heritage, of which nearly every one of us has been guilty at some time.

Less obvious factors arising from human population of the landscape may be no less serious threats to species than the catastrophic clearing of land. The pervasiveness of chemical contaminants in the environment has only recently come to be appreciated. Pesticides indiscriminately kill desirable species along with the pests which they were developed to control. More subtle are the effects of accumulation of toxins in biological food chains. The relationship of DDT to the decline of birds of prey is perhaps the best known. Pesticides are not unique, however, as evidence of PCB's had demonstrated. While some chemicals destroy life directly, fertilizers and sewage, leached or discharged into lakes and streams, promote the enrichment of these waters and lead to the extirpation of many native, freshwater species. Introduction of alien species by man can put native plants and animals at a definite disadvantage in competition. A good example of this is the invasion of thousands of marshes, lakes and bogs in New York State and elsewhere by Purple Loosestrife (*Lythrum salicaria*). Though this introduced plant is beautiful itself, its crowded, hummocky growth eliminates fragile, native vegetation at an alarming rate. The same is true of Japanese Honeysuckle (*Lonicera japonica*) and Kudzu Vine (*Pueraria lobata*) further south. Two large grasses currently rendering havoc on New York State's wetlands are Common Reed (*Phragmites communis*) and Reed Canary Grass (*Phalaris arundinacea*).

The human hand, then, may be blamed for much rarity and elimination of native plants and animals. Perhaps too much has already been said on this subject and too little thinking and serious planning done on how to co-exist with remaining natural communities. As reasoning beings who are also perpetrators of global mayhem, we find ourselves in a dilemma. Some conservationists might insist that manipulating environment is not desirable, and that destabilizing effects from management and experimentation may bring the extinction of the very species we seek to protect. Although this is a risk, lack of management for many rare associations will also bring their demise. Few communities containing rare plants are part of climax vegetation, so natural succession on sites they now occupy would mean their eventual replacement and extirpation. Though we cause much disturbance, we also remove causes of natural disturbance such as fire, stream-capture, flooding and earth slides from many areas where they once frequently occurred. Plant communities which are adapted to pioneering after such events must have those disturbances simulated or lose their suitable habitat.

Rarity and the Law

Plants belong, by law, to the landowner, whether that might be an individual, a corporation or government agency. Animals, on the other hand, have traditionally been owned by the king or government, with strong precedents passed on from British common law.

The environmental awareness of the public has increased greatly in recent years and prompted the enactment of much significant legislation. One product of Congressional activity is the Endangered Species Act of 1973. The Act was devised to prevent the extinction of plants and animals, and it addresses problems of both exploitation and habitat destruction. The Act defines an endangered species as any species of animal or plant which is in danger of extinction over all or a significant portion of its range. A threatened species is defined as one which is likely to become endangered. According to the Act, a species may become endangered or threatened through one or more of the following factors:

1) The present or threatened destruction, modification or curtailment of its habitat or range;
2) Overutilization for commercial, sporting, scientific or educational purposes;
3) Disease, predation;
4) The inadequacy of existing regulatory mechanisms;
5) Other natural or man-made factors affecting its continued existence.

Additional definitions indicate that all life forms are intended to fall within the scope of the Act, excepting only specific insects which present severe threats to man. Definitions further provide for the coverage of any individual, whether alive or dead, and any parts, and, in the case of animals, products derived from them.

The Act addresses exploitation of endangered species by prohibiting their trade in interstate and foreign commerce and their import and export. Further, the "taking" of endangerd animals is prohibited, "taking" being defined to include the killing, capture and harassment of individuals. The Act provides for the formulation of regulations concerning endangered and threatened species and prohibits the violation of such regulations; penalties are provided for civil and criminal violations of the provisions of the Act.

A particularly important section of the Act promotes the conservation of habitats of endangered and threatened species. The Act authorizes the acquisition of land for the protection of habitats of these species and directs federal agencies to insure that their activities or those authorized or funded by them do not jeopardize the continued existence of endangered and threatened species.

The Act also implements the Convention on International Trade in Endangered Species of Wild Fauna and Flora, which prohibits or regulates trade in designated species between signatory countries.

The Act prescribes strict procedural guidelines for determination of status and listing of species. These provide that species be listed only after extensive input and review by biologists, the states and the general public. This procedure insures that only species in need of protection are listed, and it provides baseline data from which further population monitoring may proceed. It does, however, take a great deal of time, and the process has been particularly slow with plants. Many of the over 3,000 species may indeed become extinct before they are considered for federal protection. This places responsibility with state and local governments and with those individuals who own the land.

New York State Rarities Considered for Federal Protection

Under the provisions of the Endangered Species Act of 1973, the U.S. Fish and Wildlife Service periodically publishes notices on species under review for federal listing. The latest such notice at the time of this publication was the *Federal Register*, vol. 45, no. 242, Monday, December 15, 1980. That publication was in part the basis for Table 1.

TABLE 1. FEDERAL STATUS OF NEW YORK STATE PLANT RARITIES (1981)

Status	Species	Common Name	Historical Distribution
LISTED THREATENED			
	Aconitum noveboracense	Northern Monk's-hood	IA, OH, NY, WI
PROPOSED ENDANGERED			
	Isotria medeoloides	Small Whorled Pogonia	CT, IL, ME, MD, MA, MI, MO,NH, NJ, NY, NC, PA, RI, SC, VT, VA, (CANADA)
UNDER REVIEW Category 1—Species for which there is sufficient information on hand to support their listing as Endangered or Threatened			
	Plantago cordata	Heart-leaf Plantain	AL, GA, IL, IN, MI, NY, NC, OH, WI
	Platanthera leucophaea	Prairie White-fringed Orchid	AR, IL, IN, IA, KS, LA, ME, MI, MN, MO, NE, NY, ND, OH, OK, SD, VA, WI, (CANADA)
	Solidago houghtonii	Houghton's Goldenrod	MI, NY, (CANADA)
	Trollius laxus ssp. *laxus*	Globeflower	CT, NJ, NY, OH, PA
UNDER REVIEW Category 2—Species which are candidates for listing pending further information on their status			
	Agalinus acuta	Gerardia (False Foxglove)	CT, MA, NY, RI
	**Bidens bidentoides*	Bur-marigold	DE, MO, NJ, NY, PA
	Calamagrostis perplexa	Wood Reedgrass	NY
	Cardamine longii	Long's Bittercress	ME, MD, NY, PA
	Helianthemum dumosum	Bushy Rockrose	CT, MA, NY, RI
	Helonias bullata	Swamp Pink	DE, GA, MD, NJ, NY, NC, PA, VA

* Too frequent in New York State to be listed threatened under our guidelines.

****Isoetes eatonii*	Eaton's Quillwort	CT, MA, NH, NJ, NY
Listera auriculata	Auricled Twayblade	ME, MI, MN, NH, NY, VT, WI
Micranthemum micranthemoides	Micranthemum	DE, DC, MD, NJ, NY, PA, VA
Narthecium americanum	Yellow Asphodel	DE, NJ, NY, NC, SC
Phyllitis scolopendrium	Hart's-tongue Fern	AL, MI, NY, TN, GA, (CANADA)
Poa paludigena	Slender Marsh Bluegrass	IL, IN, MI, NY, OH, PA, WI
Potamogeton hillii	Hill's Pondweed	CT, MA, MI, NY, OH, PA, VT (CANADA)
Potamogeton lateralis	Pondweed	CT, MA, MI, MN, NH, NY, VT
Prenanthes boottii	Boott's Rattlesnake-root	ME, NH, NY, VT
Schizaea pusilla	Curlygrass Fern	NY, NJ (CANADA)
Schwalbea americana	Chaffseed	CT, DE, KY, LA, MD, MA, MS, NJ, NY, SC, TN, VA
Scirpus ancistrochaetus	Northeastern Bulrush	MA, NY, PA, VT, VA
Scirpus longii	Long's Bulrush	CT, ME, MA, NJ, NY
**Valeriana uliginosa*	Marsh Valerian	IL, IN, ME, MI, NY, OH, VT, (CANADA)
Viola novae-angliae	New England Violet	ME, MI, MN, NY, WI
Woodsia oregana var. *cathcartiana*	Cathcart's Woodsia "Oregon Woodsia"	MI, MN, NY, WI, (CANADA)

DELETED FROM REVIEW

Category 3B—Species eliminated from consideration on taxonomic grounds: those not meeting the Act's definition of "species"

****Panicum aculeatum* =*P. scabriusculum*	Panic Grass	NY, RI to FL, TX

DELETED FROM REVIEW

Category 3C—Species eliminated from federal consideration because they were found to be commoner or less threatened than formerly believed.

Calamagrostis porteri	Reed Grass	KY, NY, NC, PA, VA, WV
Cypripedium arietinum	Ram's-head Ladyslipper	CT, ME, MA, MI, MN, NH, NY, VT, WI
Cypripedium candidum	Small White Ladyslipper	IL, IN, IA, KY, MI, MN, MO, N.E., NJ, NY

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* Too frequent in New York State to be listed threatened under our guidelines.
*** Taxonomic problems.

**Hydrastis canadensis*	Golden-seal	VT to N.E. south to AL & GA
***Muhlenbergia torreyana*	Torrey's Muhly	DE, GA, KY, NJ, NY, TN
**Panax quinquefolius*	American Ginseng	ME to MI, OK, south to LA, (FL)
**Platanthera flava*	Southern Rein Orchid	ME to MI south to GA & TX
Primula mistassinica	Bird's-eye Primrose	IL, IA, ME, MI, MN, NY, VT, WI (CANADA)

Concentration of Rare Plant Species

Due to special physiography, climate and substrates offered to migrating plants, certain regions have become centers of concentration of New York rarities. With oscillations in climate through time, countless populations have come and gone. During warming and drying trends after the last glacial period, arctic species dispersed northward through New York State while their southern populations were dying out under stress. This northward migration continued, such that the State is now too far south to provide suitable habitats for most of those species. In a number of cases, however, arctic relicts survive in cold places like canyons and crevices in high peaks. Other, more western species migrated far from their former ranges onto the glacial rubble and now persist as relicts in limestone areas where there may be less competition from common, local plants. As warming and drying of the overall climate continued, coastal plain and estuary dwellers from the south, as well as prairie plants from the midwest, migrated in. Some of these established themselves on Cape Cod or further northeast, but many are at their northeastern limits on Long Island. A warming trend reached it maximum (called the altithermal) about 5,000 years ago and subsequent cooling has resulted in contraction of the ranges of some species which were making advances to the northeast. Such major and minor climatic cycling will undoubtedly continue to be accompanied by plant dispersal, establishment and eventual extirpation with regard to any given geographical area.

The following is a listing of significant areas of rare plant concentration in New York State, both past and present. For a map of the known occurrences of plant rarities in the State, see Map 1.

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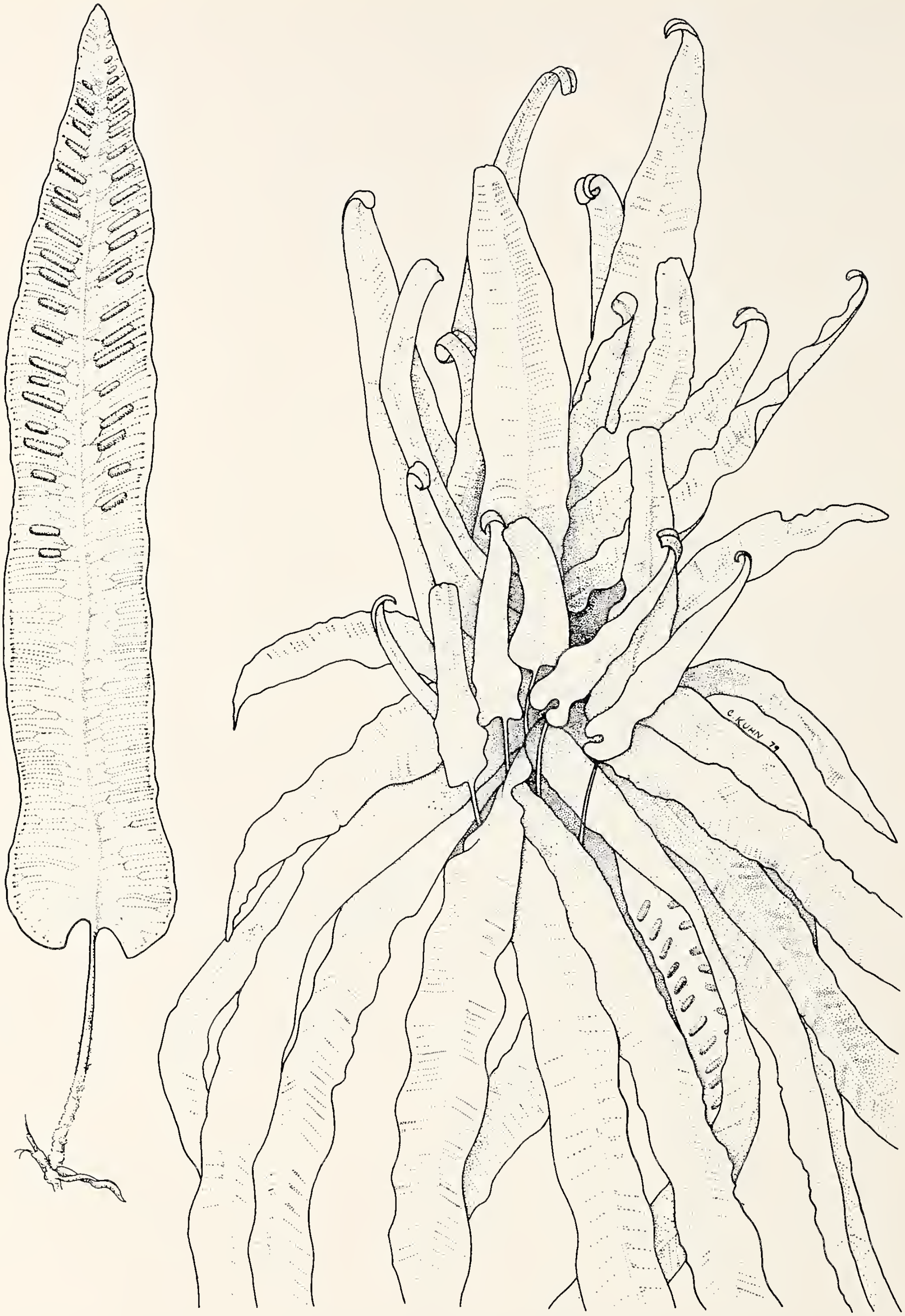
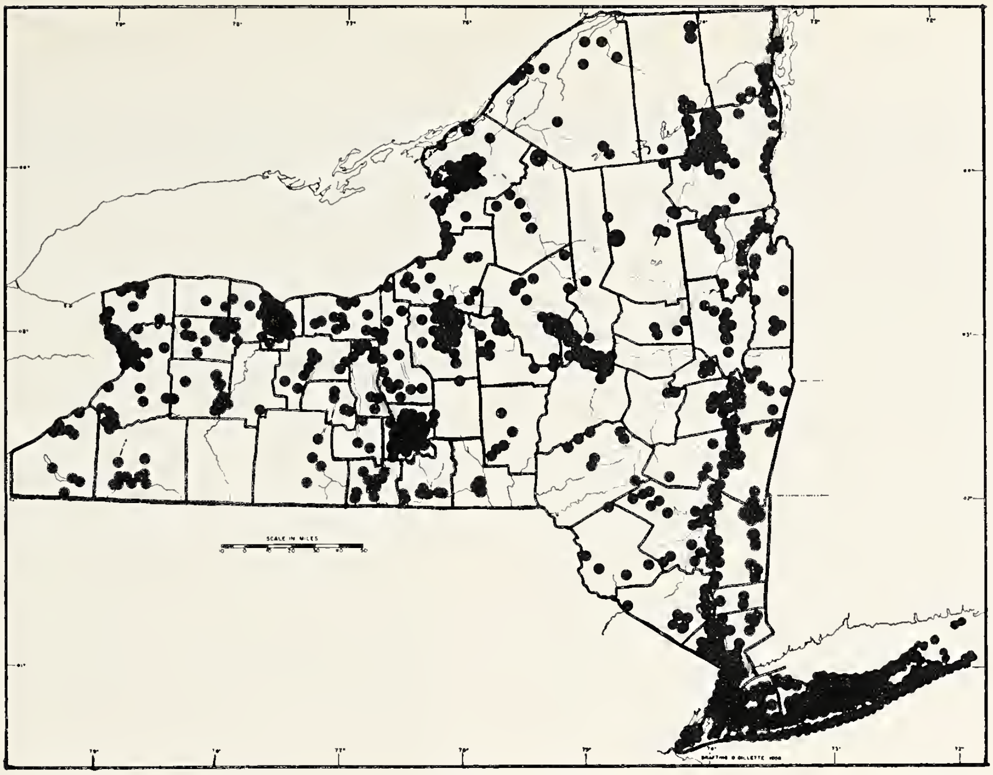
* Too frequent in New York State to be listed threatened under our guidelines.

** This species was once again being federally considered for listing at the time of this publication due to new information on its rarity.



HART'S-TONGUE *Phyllitis scolopendrium.* These unusual ferns grow in limestone areas, particularly around cliffs. They are particularly vigorous plants where they survive in New York State, but historically have been attacked by everything from the gardner's shovel to dynamite. The illustration shows new fronds unfolding to a height of about a foot.



Map 1. Historical occurrence of rare plants in New York State, showing areas of concentration. Many of these are in urban areas, with the highest concentrations of New York State rarities on Long Island.

AREAS OF HIGH EXTIRPATION

It is ironic that aggregations of rare plants and animals are often known from areas which develop into urban centers. This fact, coupled with the high rate of occurrence of rare plants near universities, has led some to speculate that we are mapping the activities of plant collectors rather than the true distribution of species. Although thoroughness of collection in an area should not be discounted, intensive local flora studies of parks or counties turn up little in the way of rarities where rarities were not already known. In addition, the areas where rarities are concentrated were well documented long before human population and land development became major factors in environmental degradation.

New York City Area—Early catalogs and descriptions portray this area as one of great beauty and diversity of species, forested for the most part, but liberally dotted with small lakes, meadows and marshy areas. Old records are rich in reports of species which used to range into the State, listing such sites as Manhattanville and Aqueduct for marsh plants. Some rarities still persist in the Bronx and on western Long Island. Nassau County, Long Island, once had a prairie—the Hempstead Plains. This was an extremely rich association of rare plants, of which a tiny remnant remains. Staten Island is perhaps the area in which the most rare species for New York have been extirpated. It is fortunate that many of these were merely northern range limits for species commoner further south. Areas to the north of the city in Westchester and Rockland Counties have been less heavily impacted, but development continues.

Buffalo-Niagara Gorge Area—This region has been highly disturbed, and a number of species which were characteristically western have been eliminated. Small White Ladyslipper (*Cypripedium candidum*), for instance, was formerly known from an island in the Niagara River which is now occupied by sewage treatment facilities. Further exploration of the less accessible parts of the gorge may turn up a few of the plant species which we now fear may be extirpated there.

Black River, Watertown Area—The limestone cliffs of this river once supported populations of a number of western species, notably Prairie Smoke (*Geum triflorum*) and Cut-leaved Anemone (*Anemone multifida*). Industrialization brought changes along the riverbanks from mid- to late-19th century, and extensive dam building in conjunction with mills (mostly now in ruins) may be blamed for extirpation in the vicinity of the cliffs and banks. Intensive searches by field botany teams have revealed only a weedy flora adjacent to the river, though the flatrock areas surrounding it are still rich in rarities in some places, as will be discussed below.

Rochester Area—Particularly in aquatic situations along and near the Genesee River, there are a number of reports of rare plants, some of which have not been verified for 120 years; some of these are certainly gone, but the search continues for survivors.

Syracuse Area—The limestone-rich, dissected topography, combined with alkaline lakes and marly bogs, once made the Syracuse region one of our richest in rare plants. Although much extirpation has occurred, there are many habitats still intact and in need of preservation, especially southeast of the city. Land fills, mining and the draining of bogs have been major causes of loss of critical habitats. Housing developments now present an even greater threat, as in most growing, urban areas.

Utica Area—Extensive marshy areas around Utica were once rich in rare plant populations. As in Syracuse, there are still such areas which have not been drained or sufficiently disturbed to destroy all of the rare plants.

AREAS OF UNCERTAIN FUTURE

Eastern Long Island Area—This extremely important area was refuge for the largest number of New York State rarities anywhere assembled. The two most important centers are: 1) northern Suffolk County from Port Jefferson to Riverhead, and 2) the entire southern peninsula from Flanders to Montauk Point, with special emphasis on the Sag Harbor and Montauk areas. Rarities concentrated in these areas not only represent migrants from the south, but some are extremely rare Coastal Plain species, under review for Federal protection.

Hudson River—From its mouth to the Albany-Troy region some 150 miles north, the Hudson River is an estuary under tidal influences. Its marshy and muddy shores offer a great variety of aquatic habitats, and are populated, as might be expected, by a number of rare plants. Threats to rarities from dredging are usually minimized by hearings and careful environmental impact statements. This is particularly important on the Hudson, since certain peripheral marshes and creek mouths harbor some of the rarest plants in New York State and in the nation.

Mohawk Area—The zone between Utica and Cherry Valley is a critical one for rare plants. It is located mostly in southern Herkimer and northern Otsego Counties. Particularly in calcareous, swampforest zones, there are known extant populations, sites of extirpation and potential sites for discovery of rarities.

Watertown Flatrock Area—Natural limestone pavement is common along the eastern shores of Lake Ontario, especially to the west of Watertown. Most of these lands are barren and devoid of significant vegetation, but pockets are to be found in which a number of rare plants are associated. Prairie bunch-grass and sedges carpet small swales.

Tompkins County-Cayuga Lake Area—Partially because of intensive plant collecting (Cornell University), but more significantly because of the superposition of an impressive array of calcareous habitats, the Cayuga Basin and adjacent Tompkins County comprise a well-known rare plant center. The marly marshes and swales are constantly in danger of being drained or filled, and lakeshore plants are equally in peril. Cliff dwellers are afforded some degree of protection within parks, but remain in danger on private land. Extensive botanizing in the three counties to the south and east by the botanist Stanley J. Smith failed to reveal the richness of rarities found in Tompkins County and the Cayuga Lake Basin.

The Glen Area—This important rare plant area lies along the upper Hudson River in Warren and Essex Counties.

Bonaparte Swamp—Northern Lewis County, particularly the swampforest area, is also rich in rarities.

Pine Plains—The sandy, marly area in northern Dutchess County is also rich in plant rarities.

AREAS AFFORDED SOME PROTECTION

Bergen Swamp—This area has received much attention from botanists and zoologists, and is protected by the Bergen Swamp Society (private ownership). Poaching still occurs and should be highly discouraged by all before the area loses more of its marl-bog flora.

Valcour Island—This lime-rich island in Lake Champlain has long been known for its New York rarities. The Nature Conservancy purchased much of the southern end of the island, and now most of the island is under control of the State of New York. Limited accessibility and State supervision afford good prospects for protection if the area is not developed for further recreation.

The High Peaks—The Adirondack Peaks are rich in arctic-alpine flora, members of which are rare in New York State or at their southern limits of distribution. Most of the land is State-owned and supervised. The main threats to alpine vegetation are from hikers who trample the summits; in spite of this, a number of rarities are hanging on to life.

Status Code for New York State Rarities

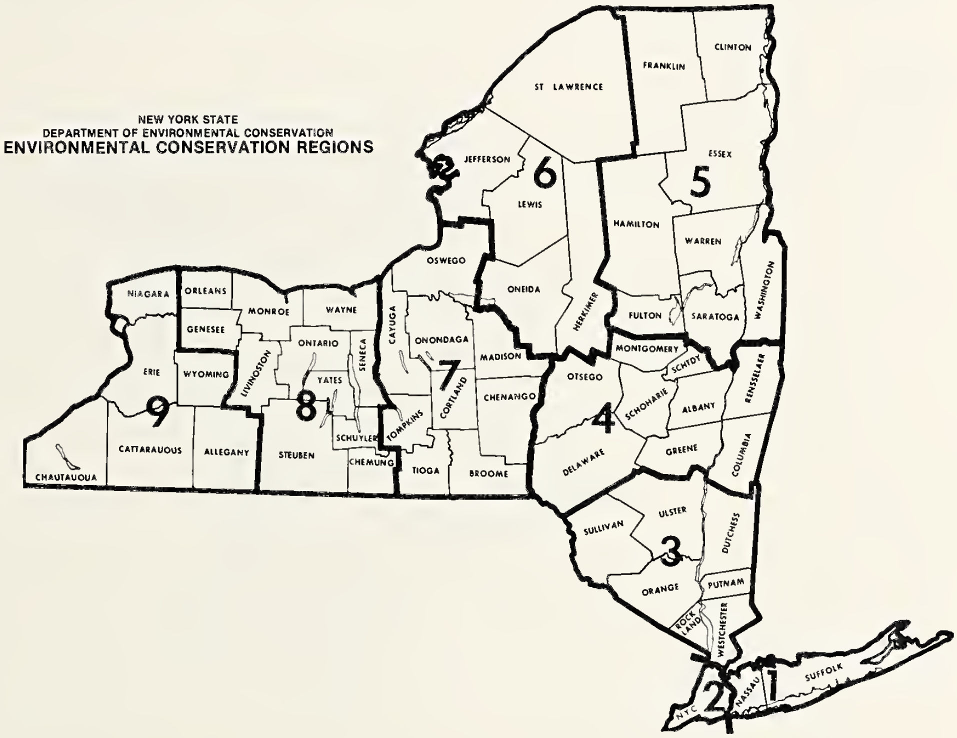
The status code used here does not have a basis in New York State law at the time of this publication. It is a form of designation proposed by the authors to indicate both rarity and need for protection for each species listed. The two-symbol code separates actual rarity from desired protection priorities, since these do not always coincide. The letter indicates rarity status as follows:

X — probably extirpated in New York State
E — endangered in New York State
T — threatened in New York State
C — commercially exploited in New York State

The numbers indicate recommended priority for protection, whether by law or by conscience of the land owner. These were derived through consideration of overall rarity and pattern of distribution of the species, as well as likelihood of extirpation within and outside the State. High priority has been assigned to those species studied federally and found to be endangered or threatened on the national level. Numerical priorities are:

1—highest priority; protection should be mandatory
2—protection strongly recommended, even if the habitat supports no other rarities
3—protection recommended if in combination with other rare species

Thus, E-1 has the highest priority followed by T-1, E-2, T-2, E-3 and T-3. Plants listed X-1, X-2 or X-3 would take on new numerical designations E-1, T-1, etc. if rediscovered.



Map 2. Counties of New York State and the Districts (Regions) of the New York State Department of Environmental Conservation (D.E.C.) referred to in the text.

Rare Ferns of New York State

The Pteridophytes comprise the group with the largest number of rarities in New York State. Because they reproduce by windborne spores, the likelihood of long distance dispersal is great for them. Thus, species from western North America may occasionally establish in the east when their spores are earried by prevailing winds to suitable conditions. In addition, arctic ferns have established in severe habitats in the Adirondacks and in extreme cold air drainage zones in the deep Catskill cloves. The fifteen ferns described and pictured here are known to occur nine times or fewer in New York State, and represent some of the most endangered members of our flora.

MOUNTAIN SPLEENWORT

Asplenium montanum Willd.

Status: Threatened in New York State (T-3)
Rarity: These plants are very rare in New York and New England, but less so in the central and southern Appalachians where they range to Georgia.
Habitats: Soil in crevices of acid rocks such as sandstone in protected, frequently shaded places. The soil pH is often 4–6.
D.E.C. Region: 3
Counties: Dutchess, Ulster

This small fern has its fronds pinnately divided with the leaflets (pinnae) cut and lobed. The leaf stalk (stipe) is greenish above and brown below, and is not scaly or hairy. Species with which it might be confused are: Wall Rue (*A. ruta-muraria*), whose stipes are all green and whose leaves have fewer pinnae, and Green Spleenwort (*A. viride*) which has hair-like scales on the leaf stalk. It also looks a little like Fragile Fern (*Cystopteris fragilis*) but does not bear its spore clusters (sori) near the margins of the pinnae.

GREEN SPLEENWORT

Asplenium viride Huds.

Status: Threatened in New York State (T-3)
Rarity: This species is rare at its southern limits in the eastern United States and Canada, but it has a wide range to the north extending to Alaska, Eurasia and Greenland. In the Western U.S. it is found south to Colorado and Washington State. Green Spleenwort has been found at a single locality in New York State and is equally rare in Maine and Vermont.
Habitats: Soil in crevices of limestone areas, especially cliffs and talus, often in partially shaded situations. Soil pH is neutral to slightly basic.
D.E.C. Region: 6
County: Lewis

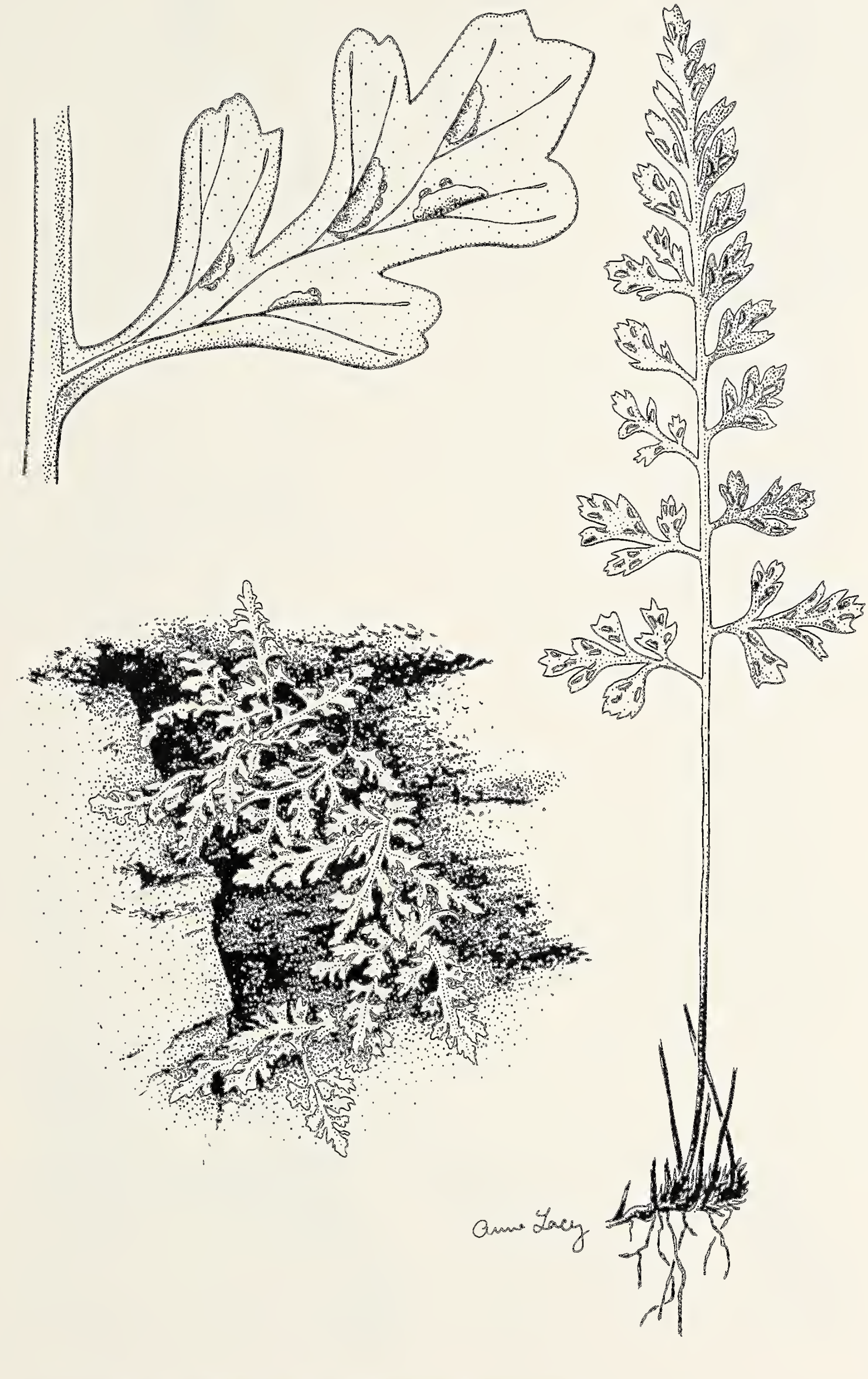
This slender fern has pinnately divided fronds with toothed or shallowly lobed pinnae. Like the Mountain Spleenwort its leaf stalks are green above and brown toward the bases. The pinnae are not as deeply divided, however, and the leaf stalks have brownish, hair-like scales. Sori are narrow, borne near the midribs.

MOONWORT

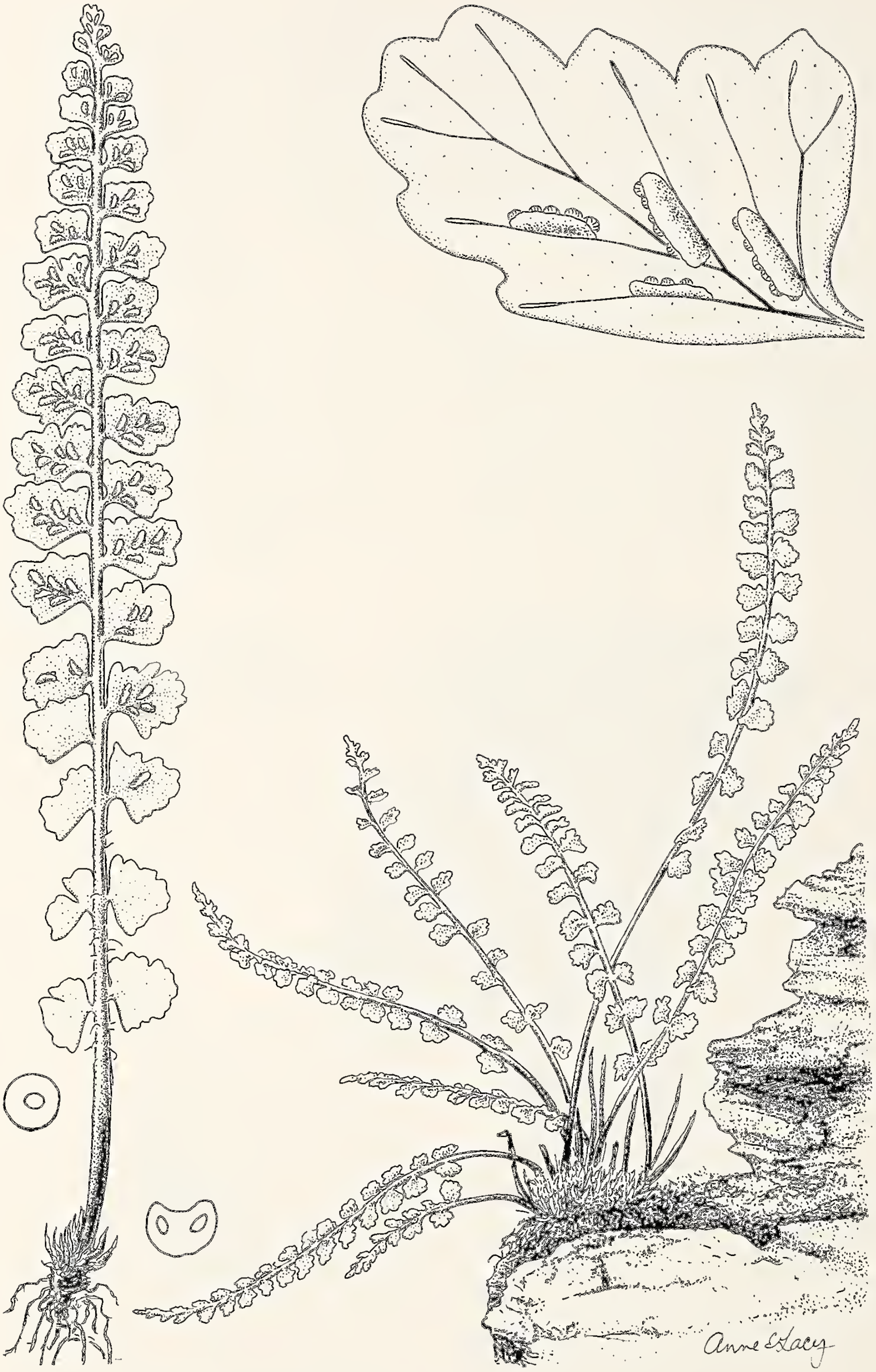
Botrychium lunaria (L.) Sw.

Status: Endangered in New York State (E-3)
Rarity: These plants are known from a single population in the State where they are extremely vulnerable. The other two sites from which they were known have been destroyed. The species is a widespread one, ranging to Alaska, Eurasia and Australia, but rare in the eastern United States.
Habitats: Limestone areas (mixed hardwood-conifer woodland in New York) in tundra, talus, meadows, woods or on shores. Soil is neutral to slightly alkaline.
D.E.C. Region: 7
County: Onondaga

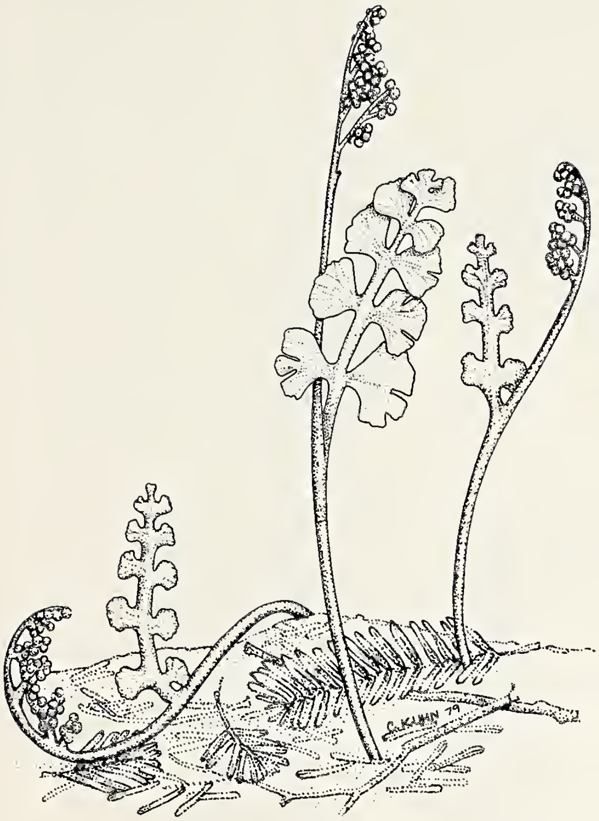
These tiny plants consist of a fertile segment and a simple vegetative leaf borne on a common stalk. The fertile stalk has branches near the tip which bear clustered sporangia. The leaf is pinnately divided with fan-shaped leaflets (pinnae). The plants are only visible for a couple of months each summer, as they wither soon after shedding spores. They may easily be confused with Mingan Moonwort with which they may grow in mixed colonies (see below).



MOUNTAIN SPLEENWORT *Asplenium montanum.*



GREEN SPLEENWORT *Asplenium viride.*



MOONWORT AND MINGAN MOONWORT
Botrychium lunaria; Botrychium minganense. **The tiny Moonworts were once known from three locations in the State, but now persist at only one location with fewer than 40 individuals. Moonwort (center) sometimes grows with its (polyploid) relative, Mingan Moonwort (left and right).**

MINGAN MOONWORT

Botrychium minganense Victorian

Status: Endangered in New York State (E-2)
Rarity: These plants are known from the same single colony, mixed with the above species. The plants have a range similar to that of Moonwort, often occurring with it. This species is extremely rare in the eastern United States.
Habitats: As with the species above
D.E.C. Region: 7
County: Onondaga

This species has twice the number of chromosomes of the Moonwort. Though closely related to *B. lunaria*, it may be distinguished by the shape of pinnae (compare in figure above), its fleshier texture and larger spores.

TERNATE GRAPE FERN

Botrychium ternatum (Thunb.) Sw.

Status: Threatened in New York State (T-2)
Rarity: This species has been found in three locations in New York State. Specimens were on sheets mixed with other species of *Botrychium*, indicating that they grow together. It is a northern species, not well understood by botanists in general, and may be more common in Canada than presently known.
Habitats: Open woods and clearings in organic to gravelly soils, often in acidic situations.
D.E.C. Regions: 6, 7
Counties: Onondaga, St. Lawrence

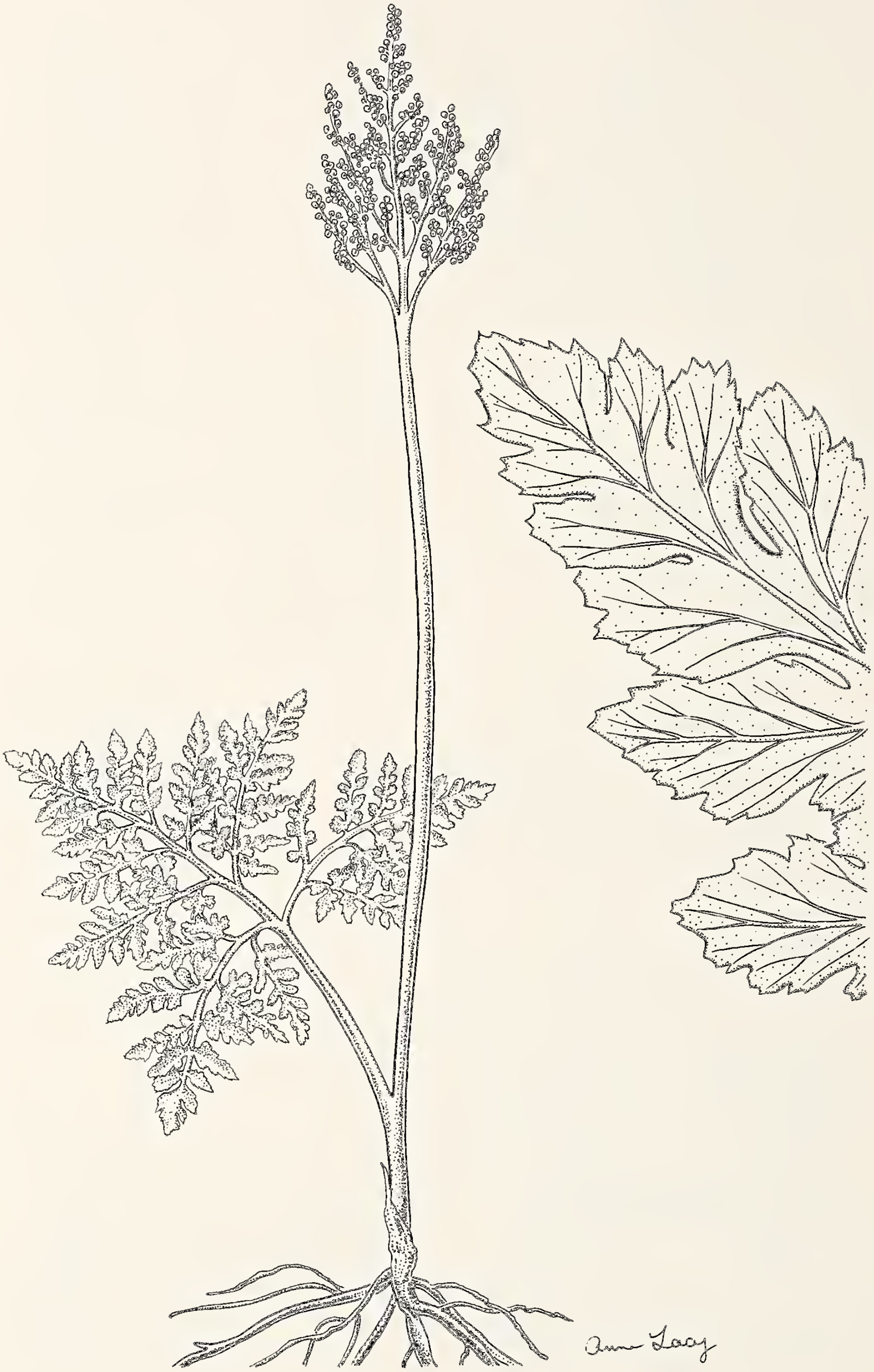
These plants have a fertile segment and a single leaf borne on a common stalk. The fertile stalk is profusely branched at the tip with copious sporangia. The leaf is much divided and lobed. This species is much like the Leathery Grape Fern (*B. multifidum*), but has many small, sharp teeth on the lobes of the leaflets.

WOOLLY LIP-FERN, HAIRY LIP-FERN

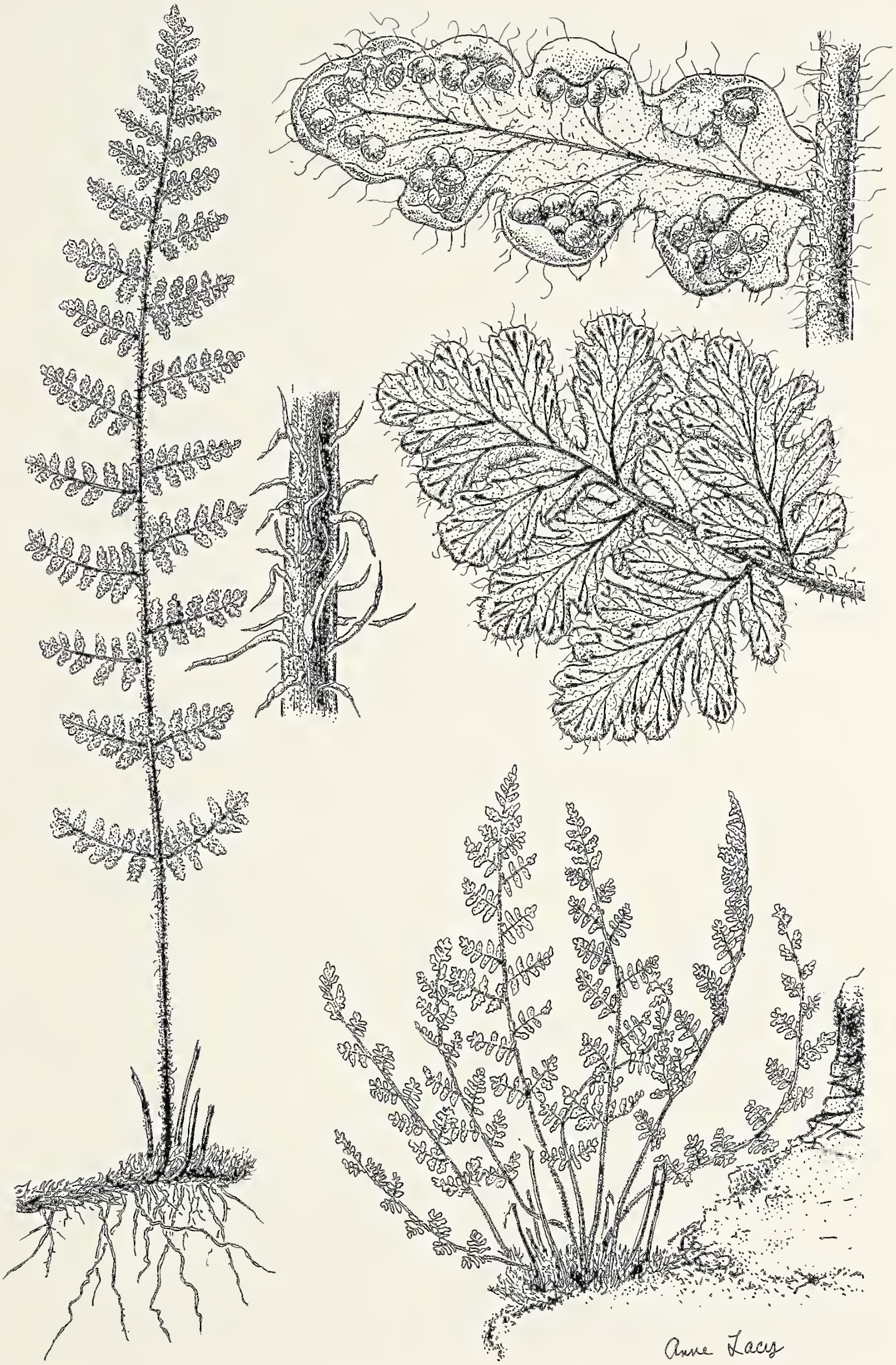
Cheilanthes lanosa (Michx.) Eat.

Status: Possibly extirpated (X-3) in New York State (last reported 1888).
Rarity: Very rare in New York and Connecticut, but less so further south and in the midwest. Ranging mostly from New Jersey and Pennsylvania to Arkansas and Kansas. This species should be actively sought in the southernmost counties in New York.
Habitats: Relatively dry, rocky sites, such as ledges and cliffs; found on a wide range of soils, from those derived from acidic sandstone to basic limestone.
D.E.C. Regions: 2, 3
Counties: Dutchess, New York, Ulster, Westchester

This is our only representative species of this mostly western genus. The leaves may shrivel and curl during dry weather, but will revive with rain, much like Resurrection Plants (*Selaginella* species). Fronds are evergreen, mostly bipinnately compound with lobed pinnae, very hairy, especially on the leaf stalks, Spore clusters are enrolled in the margins of the pinnae. This distinctive species may turn up if it is sought, though it has not been seen in the State in the 20th century.



TERNATE GRAPE FERN *Botrychium ternatum*



WOOLLY LIP-FERN *Cheilanthes lanosa*

LOWLAND FRAGILE FERN

Cystopteris protrusa (Weath.) Blasd.

Status: Threatened in New York State (T-3)
Rarity: Rare in New York, reaching only the western and southernmost counties near the northern limits of its distribution range; ranging into Minnesota, but mostly southern, occurring south to Alabama and Louisiana.
Habitats: Moist, often rich, organic soils in limestone-rich woods, swampforests and clearings.
D.E.C. Regions: 1, 2, 9
Counties: Erie, Richmond, Suffolk

This species is very similar to the common Fragile Fern *(Cystopteris fragilis)*, but the underground stem (rhizome) protrudes beyond the fronds of the season and is more elongate in general. The pinnae are also generally more elongate or lance-shaped, while those of Fragile Fern are blunter and bear fewer sori.

CLIMBING FERN, HARTFORD FERN

Lygodium palmatum (Bernh.) Sw.

Status: Endangered in New York State (E-2)
Commercially exploited in the past.
Rarity: These plants are extremely rare in the northern part of their range of distribution in New England and New York State. Southward the distribution of the species is spotty from the coastal plain west to Kentucky.
Habitats: In New York the habitats have been rich, open woods, borders and thickets; elsewhere the species is also known from swamps and marshes.
D.E.C. Regions: 3, 5, 7
Counties: Chenango, Greene, Oneida, Onondaga, Saratoga

This unusual fern is a true vine. The fronds climb on other vegetation or ascend from ground level to a position where they nod in the wind and may contact other plants. The leaves are of two types. Lower leaves are broad and palmately 5-9 lobed, while the upper, fertile leaves are finely divided into tiny segments. These plants have been commercially gathered in the past for use in house decorations, flower arrangements and for cultivation.

SMOOTH CLIFF-BRAKE

Pellaea glabella Mett.

Status: Threatened in New York State (T-3)
Rarity: This species is distributed mostly south and west of New York State, being rare in New York and Vermont at the eastern edge of its distribution range. It is found in the State nine times in eight counties.
Habitats: Open cliffs, ledges and talus in rich, often moist soils; often on limestone, but may also be found over sandstone or shale, the soil pH being near neutral.
D.E.C. Regions: 3, 4, 5, 6, 7, 9
Counties: Albany, Columbia, Dutchess, Jefferson, Niagara, Onondaga, Warren, Washington

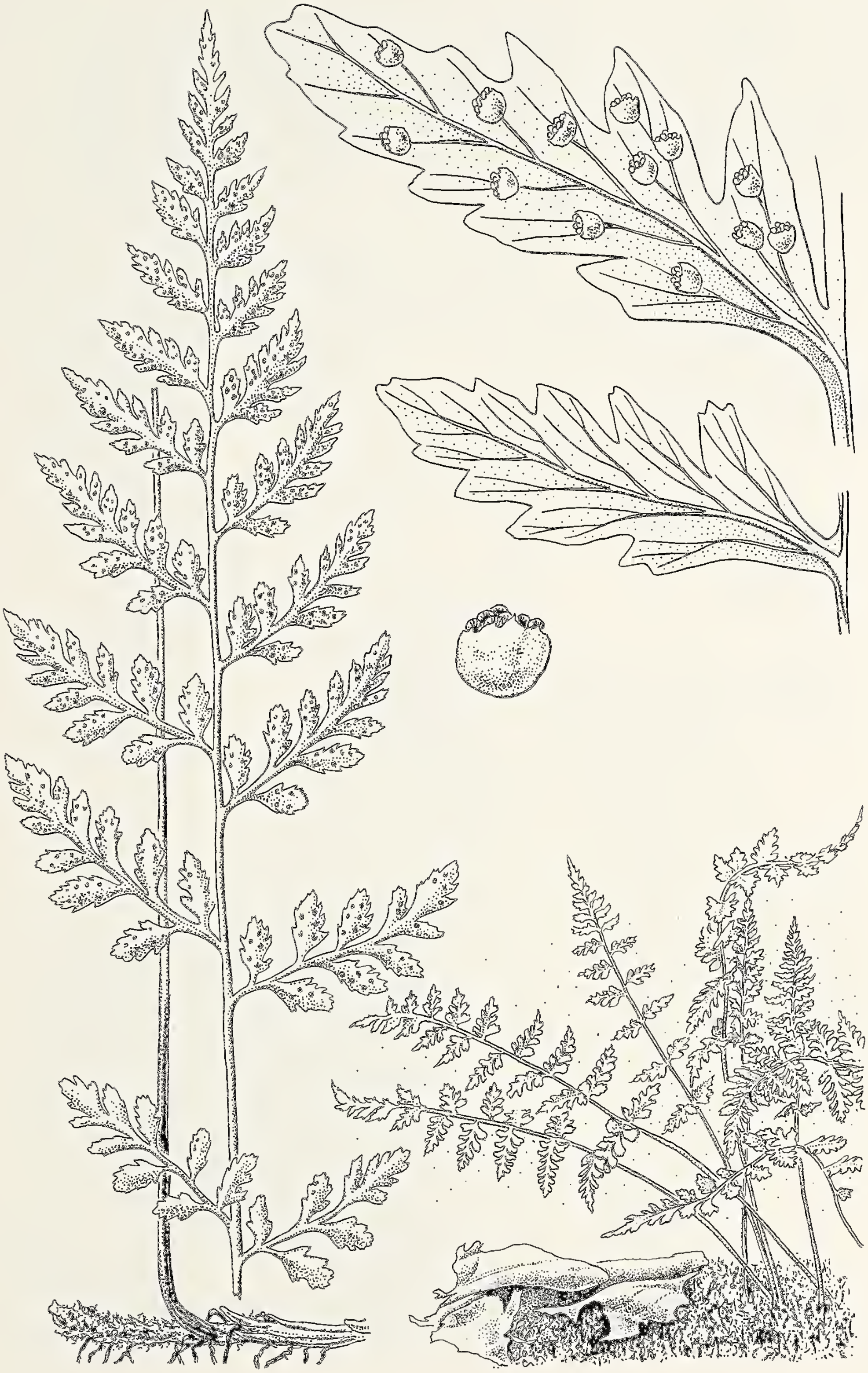
These plants have fertile and sterile leaves which look much alike. Unlike the Purple Cliff-brake *(P. atropurpurea)*, the leaves are nearly hairless, bluish-green rather than gray-green, and the lower pinnae have practically no stalks.

HART'S-TONGUE

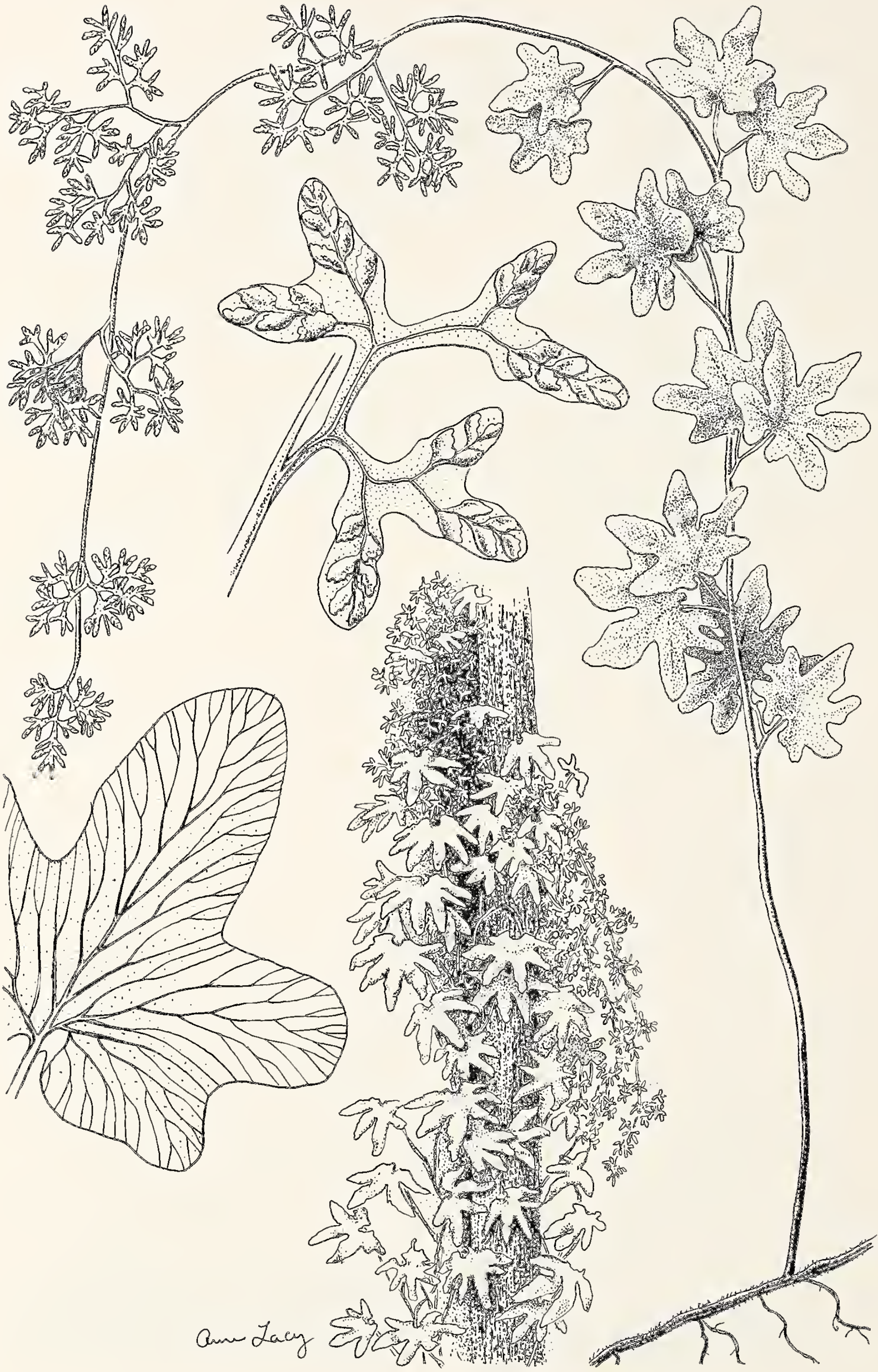
Phyllitis scolopendrium (L.) Newm.

Status: Endangered in New York State (E-1)
Federally considered for listing.
Rarity: This species is known from Europe, but is very rare and sporadic in North America. It is known from a few localities in New York, Michigan, British Columbia, Tennessee, Alabama and Georgia. It is vulnerable to collection due to its spectacular appearance.
Habitats: In New York it grows in rich, moist soil on limestone slopes, in depressions and on shaded cliff margins; elsewhere it is known from open, limey woods.
D.E.C. Region: 7
Counties: Madison, Onondaga

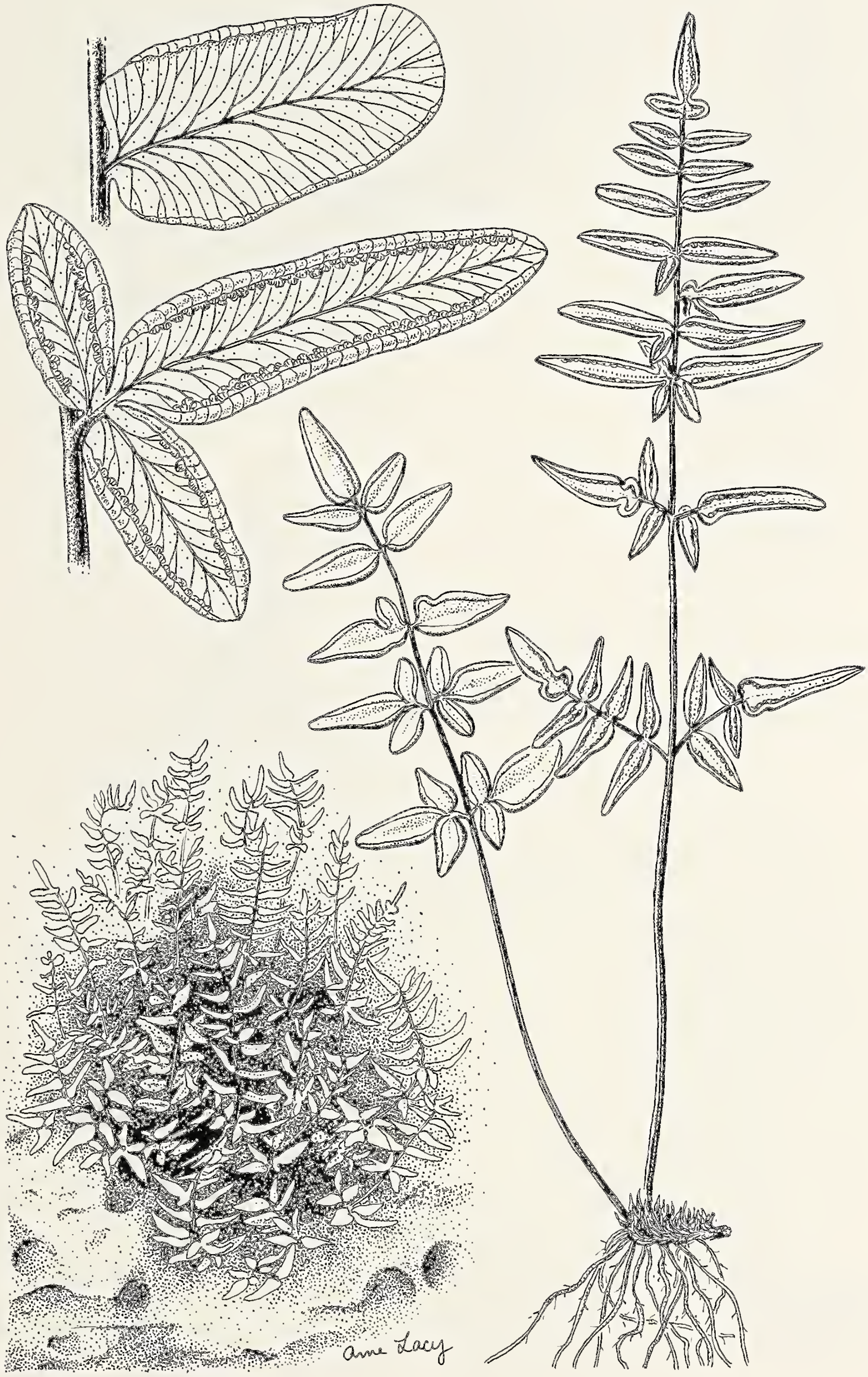
This striking plant has broad, strap-shaped blades and derives its name from the similarity of its leaf to the tongue of a deer. A leaf may be over a foot long and two inches wide. Spore clusters are borne in diagonal lines (sori) along the undersurfaces. The plants are in danger of commercial exploitation where not protected.



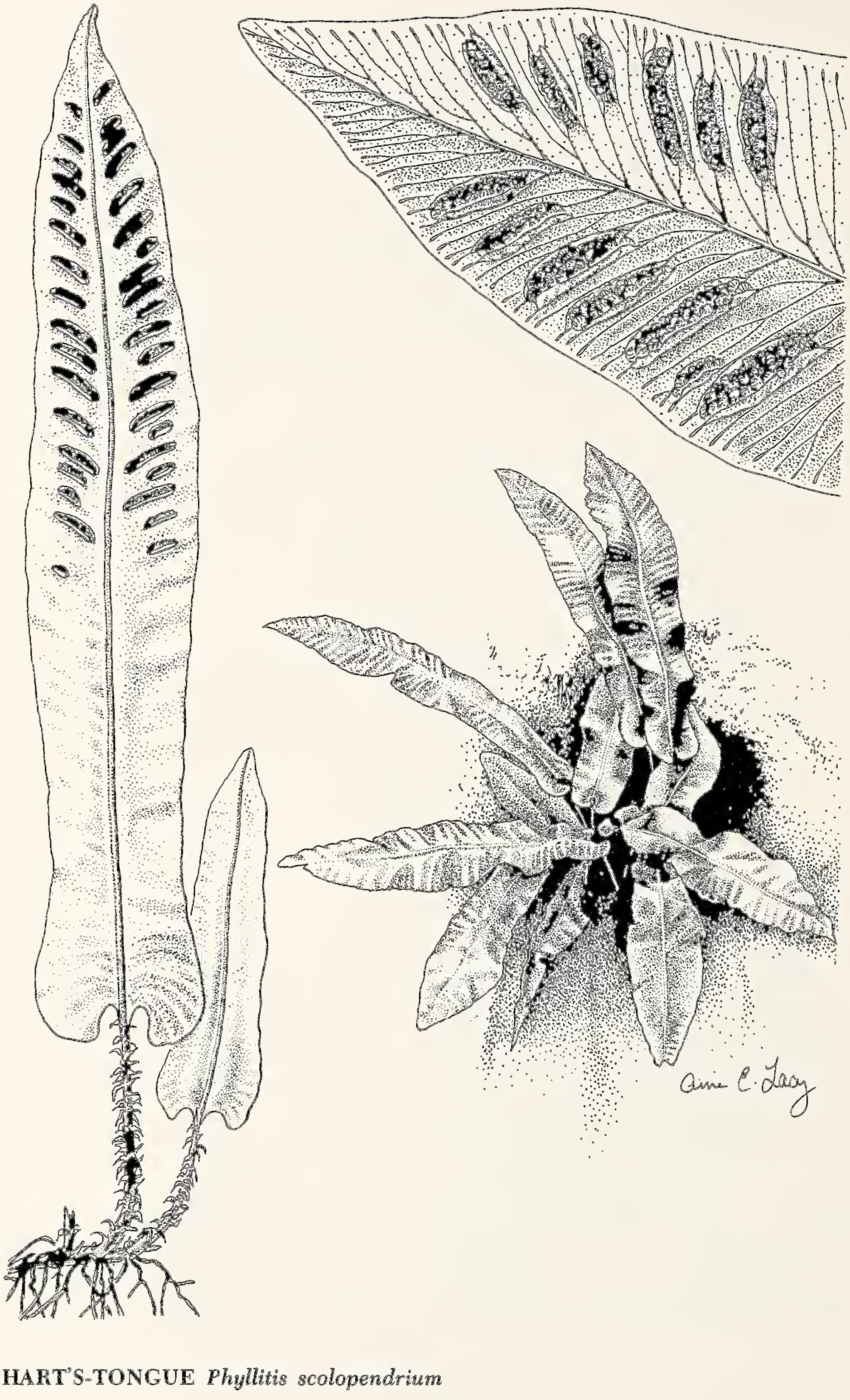
LOWLAND FRAGILE FERN *Cystopteris protrusa*



CLIMBING FERN *Lygodium palmatum*



SMOOTH CLIFF-BRAKE *Pellaea glabella*



HART'S-TONGUE *Phyllitis scolopendrium*

NORTHERN HOLLY FERN

Polystichum lonchitis (L.) Roth

Status: Endangered in New York State (E-3)

Rarity: This species, though extremely rare in the eastern United States, is a relatively common, widespread Holly Fern of the northwestern states, western Canada and Alaska. It is also a native of Eurasia.

Habitat: Limestone cliffs and talus, in its eastern range, to shady fir forest and thicket situations in the west.

D.E.C. Region: 9

County: Cattaraugus

This species most resembles the common Shield or Christmas Fern *(P. acrostichoides)* of the east, but the fertile pinnae are not noticeably reduced in size. The sterile pinnae are also gradually reduced in size toward the base of the frond.

CURLYGRASS

Schizaea pusilla Pursh

Status: Endangered in New York State (E-1) Federally considered for listing.

Rarity: New York State has a single known population of these tiny plants, while the only other known United States locations are in the New Jersey Pine Barrens. This species is also rare in the Canadian Maritimes.

Habitats: Sandy bogs and dune depressions, wet, sedgy areas and hummock borders in fens.

D.E.C. Region: 1

County: Suffolk

As some of the smallest members of the flora, these plants can be easily overlooked; however, the habitats where they might grow have been searched in New York with no success. These tiny ferns are less than two inches tall when mature, and consist of slender, thread-like leaves and a tiny naked stalk bearing a few sporangia at the tip. Even when their location is known, they are difficult to find among the matted sedges and grass.

ALPINE WOODSIA, NORTHERN WOODSIA

Woodsia alpina (Bolt.) S.F. Gray

Status: Threatened in New York State (T-3)

Rarity: This species is arctic-alpine and ranges southward to New York, Vermont and Maine where it is rare on peaks at its southern limits. It is also found in northern Eurasia.

Habitats: Open rocky places, ledges, and talus to fell-fields and tundra further north. Soil may be limestone-rich to neutral or slightly acid.

D.E.C. Regions: 3, 5

Counties: Essex, Ulster

Woodsias are not easily distinguished from one another, especially in early stages of growth. Alpine Woodsia grows in very cold habitats and has very few scales on the leaf stalks, as opposed to the more common Rusty Woodsia (*W. ilvensis*). The stalks are brownish toward the bases and have a few scales, unlike Smooth Woodsia *(W. glabella)*, which has green, scaleless ones. The pinnae (leaflets) are oval to oblong, lobed and cut.

SMOOTH WOODSIA

Woodsia glabella R.Br.

Status: Threatened in New York State (T-3)

Rarity: These plants are very rare in Maine, New Hampshire, Vermont and New York, where they reach their southern limits of distribution in the Catskill Mountains. They range to the Arctic.

Habitats: Cliffs and ledges to tundra and talus, often in lime-rich areas, but soils are often near neutral.

D.E.C. Regions: 3, 5, 6

Counties: Essex, Green, Herkimer

This species is found in similar habitats to those of Alpine Woodsia, but may be distinguished by its totally green, hairless and scaleless stalks. The pinnae (leaflets) are nearly circular to triangular, lobed and cut, without hairs.

CATHCART'S WOODSIA, "OREGON WOODSIA"

Woodsia oregana D. C. Eat. var. *cathcartiana* (Rob.) Mort.

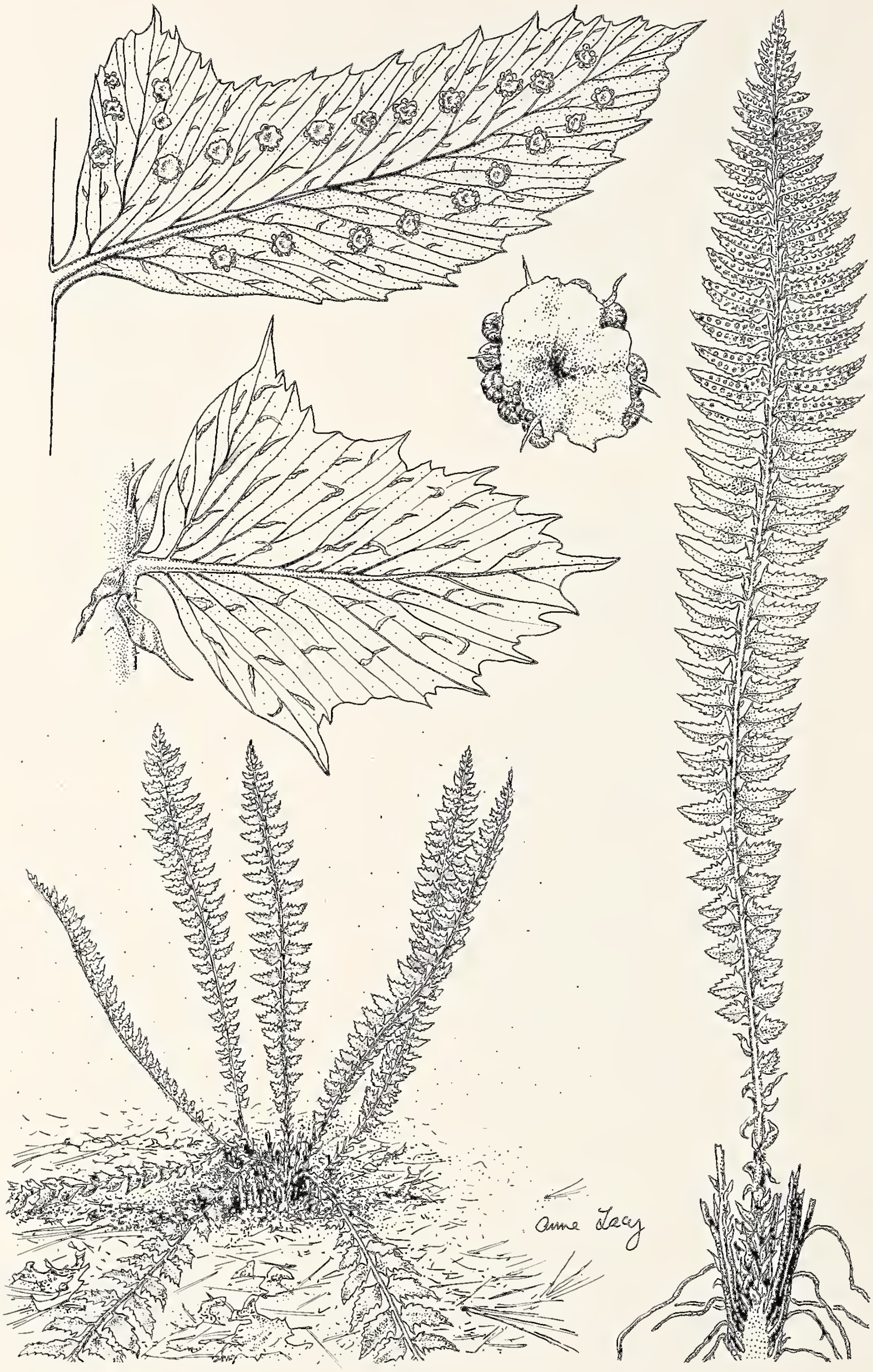
Status: Endangered in New York State (E-1) Federally considered for listing.

Rarity: An extremely rare variety of a widespread western species. It is found in a single New York location (a single plant), and is almost as rare in Michigan, Wisconsin, Minnesota and Canada. It is a strong variety, considered by some authors to be a full species.

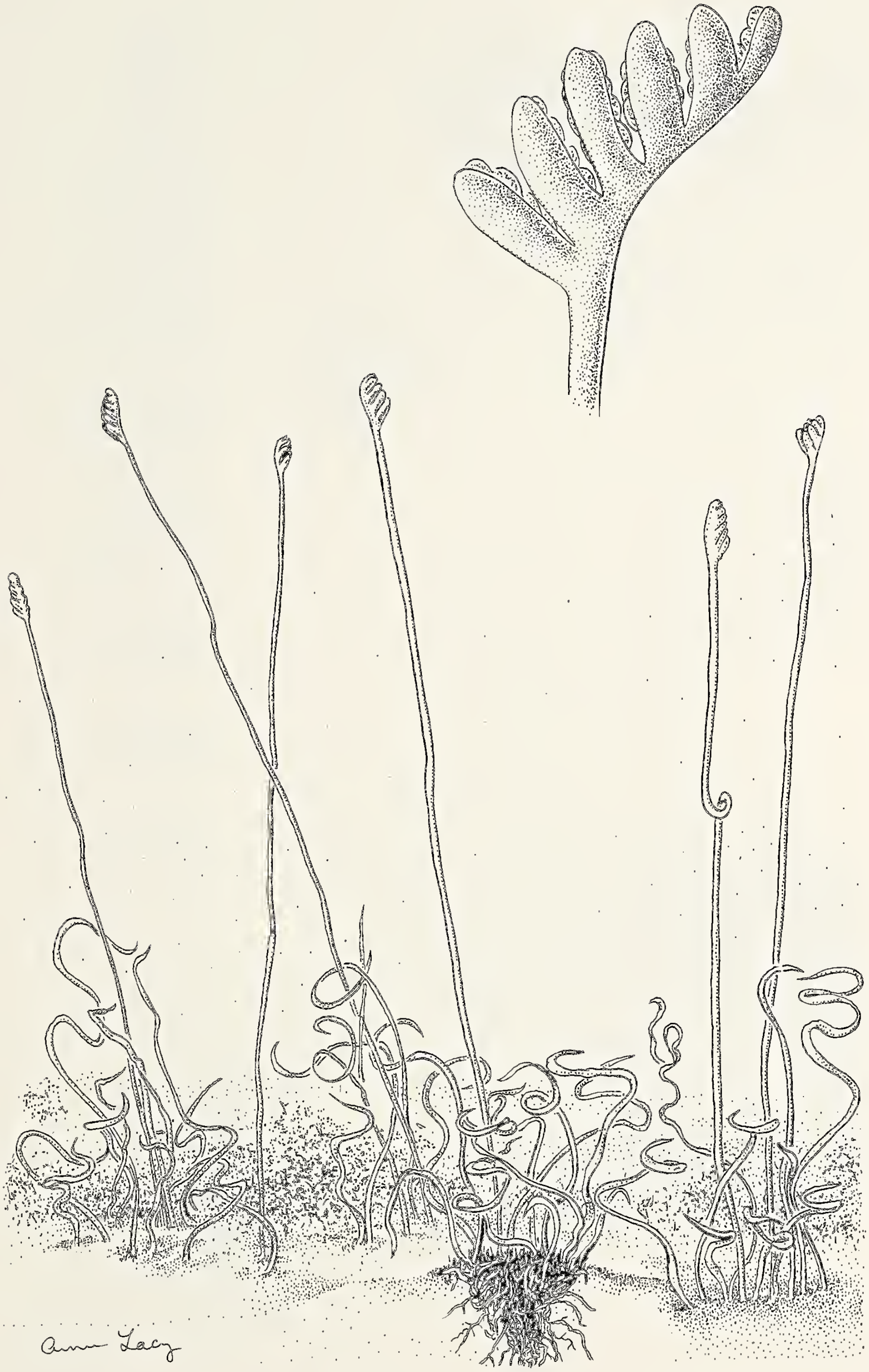
D.E.C. Region: 8

County: Ontario

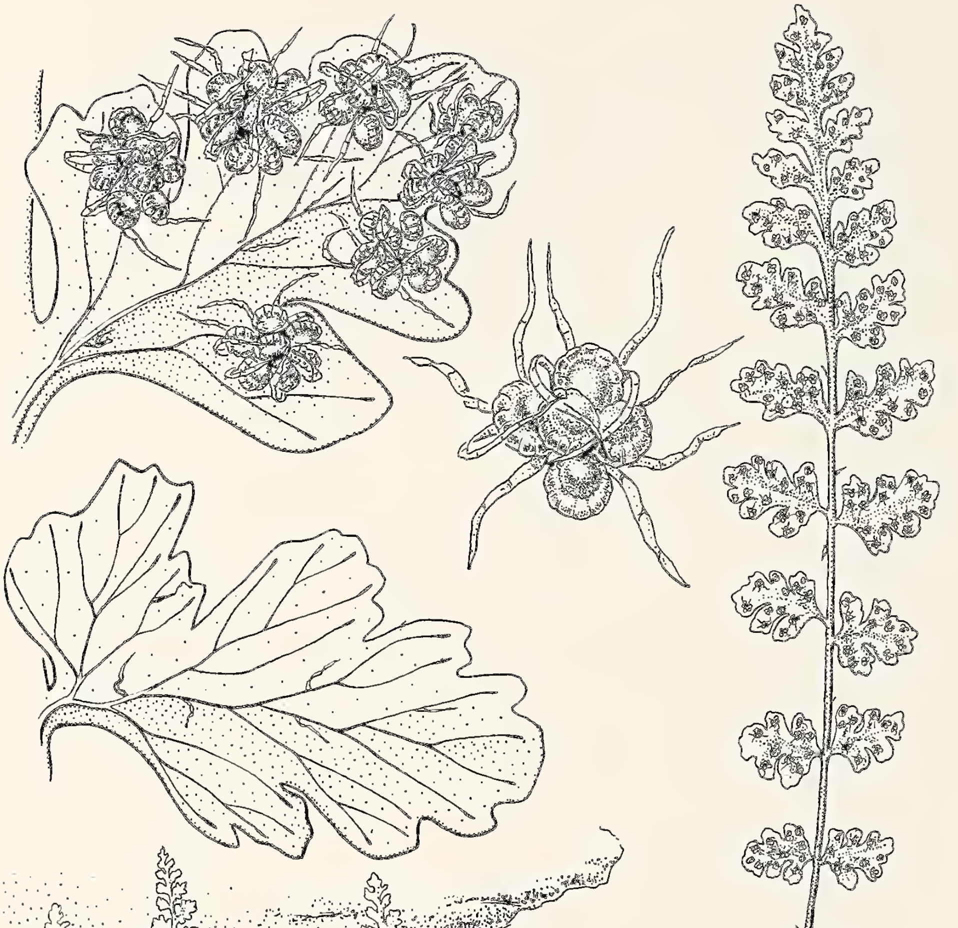
Of our native ferns, Cathcart's Woodsia most resembles Blunt-lobed Woodsia (*W. obtusa*), from which it differs in having stalks without hairs and with scales only at the bases, pinnae (leaflets) with fewer pairs of lobes (2-5), and spore clusters with hair-like rays. The pinnae are elongate with more lobes than either Smooth or Alpine Woodsia. This plant is extremely endangered and may soon be eliminated from the New York State flora.



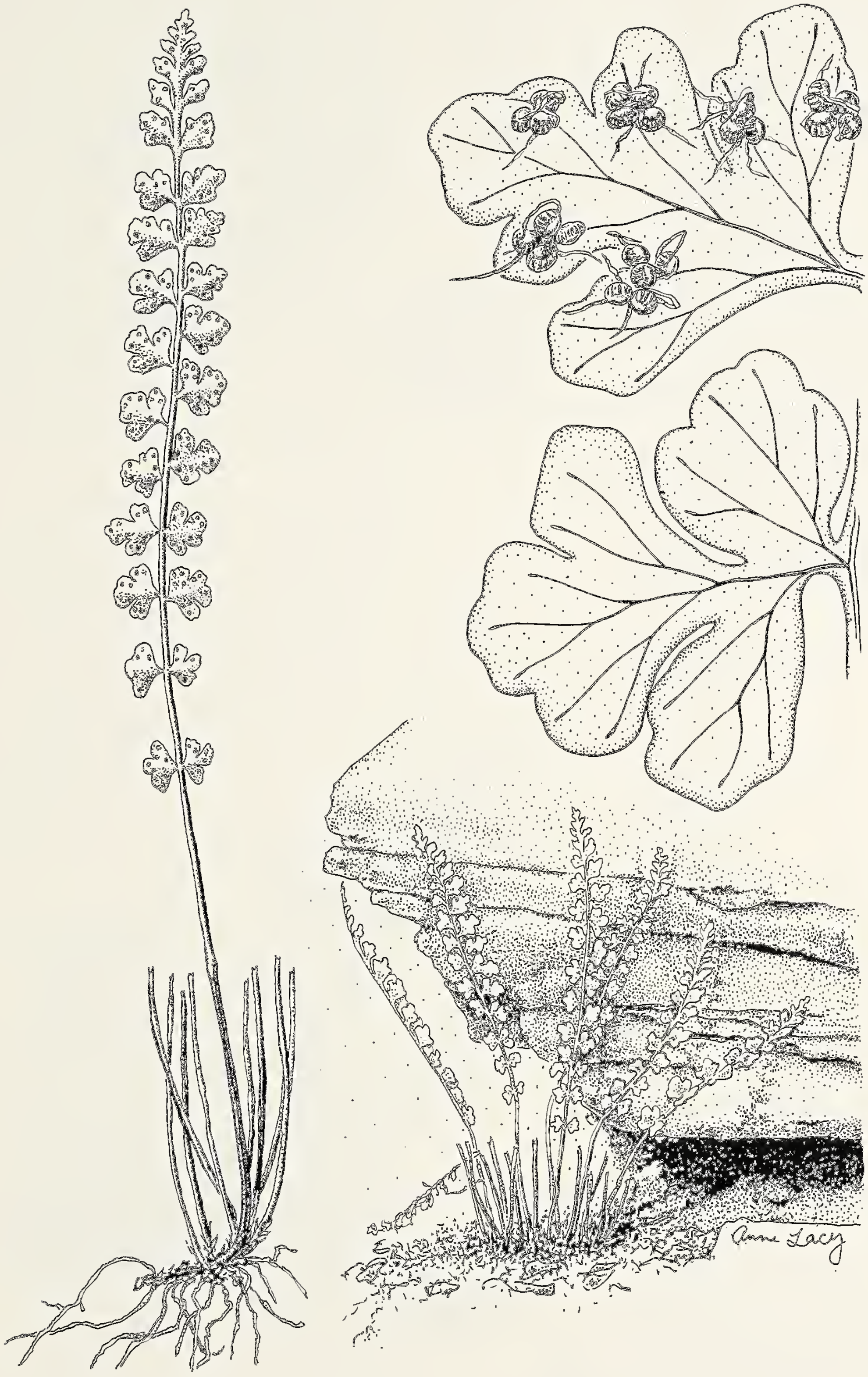
NORTHERN HOLLY FERN *Polystichum lonchitis*



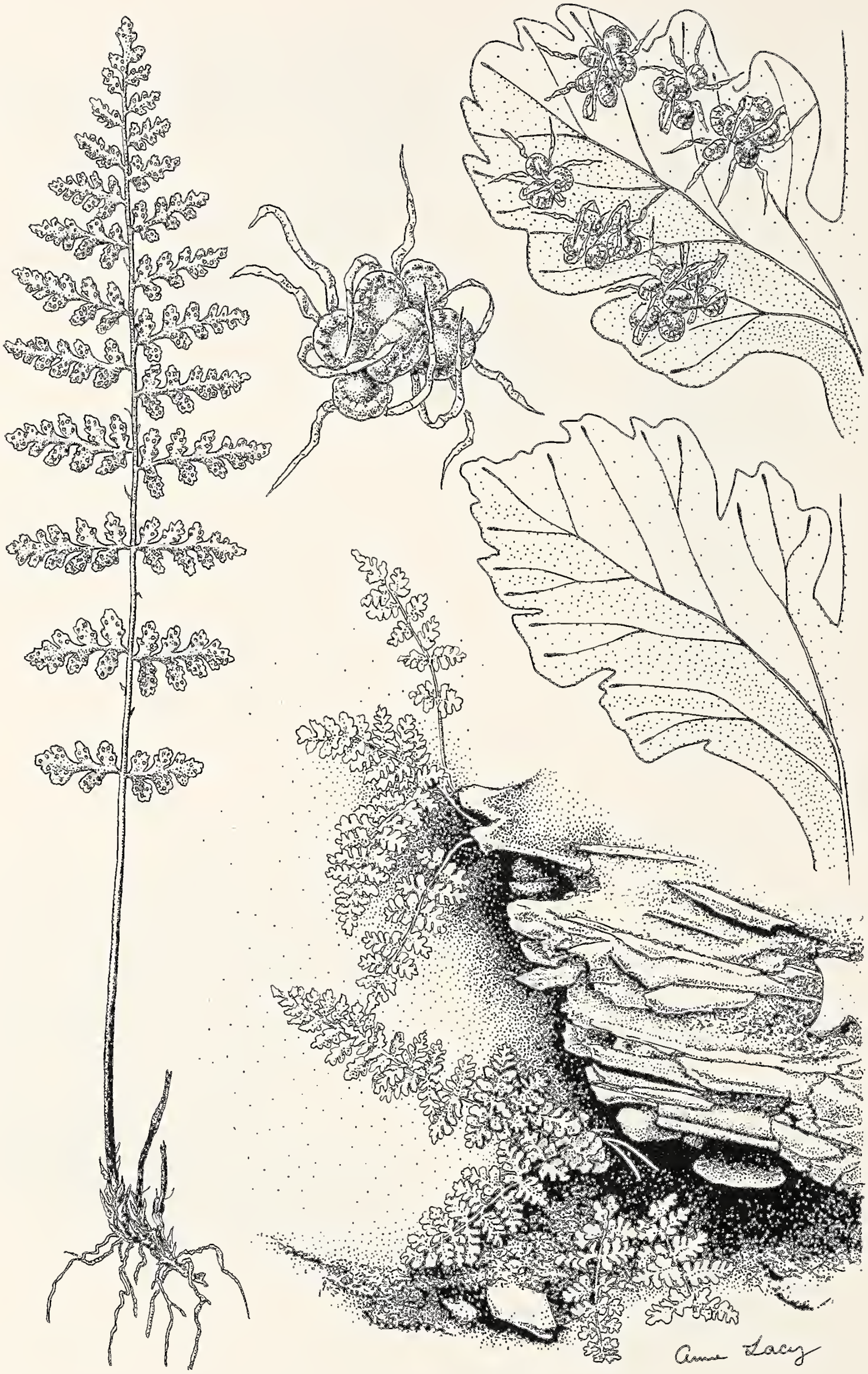
CURLYGRASS *Schizaea pusilla*



ALPINE WOODSIA *Woodsia alpina*



SMOOTH WOODSIA Woodsia glabella



CATHCART'S WOODSIA *Woodsia oregana* var. *cathcartiana*

Rare Orchids of New York State

Orchids are highly susceptible to extirpation through a variety of natural and man-made processes. They are often among a region's rarest species, and this is unquestionably true in New York State. Orchids live in precarious associations with root fungi, which supply them with water and nutrients, but also present them with a constant threat of uncontrolled infection and death. It is consequently not surprising that many orchids exhibit precise habitat requirements and are often limited to unusual environments. Most species are very susceptible to slight alterations in their environment. Moisture changes, successional changes, and other subtle alterations may be as lethal as outright destruction of an area through excavation, cultivation, or other development. Furthermore, many species are short-lived, and colonies depend on abundant seed production and seedling-establishment for survival.

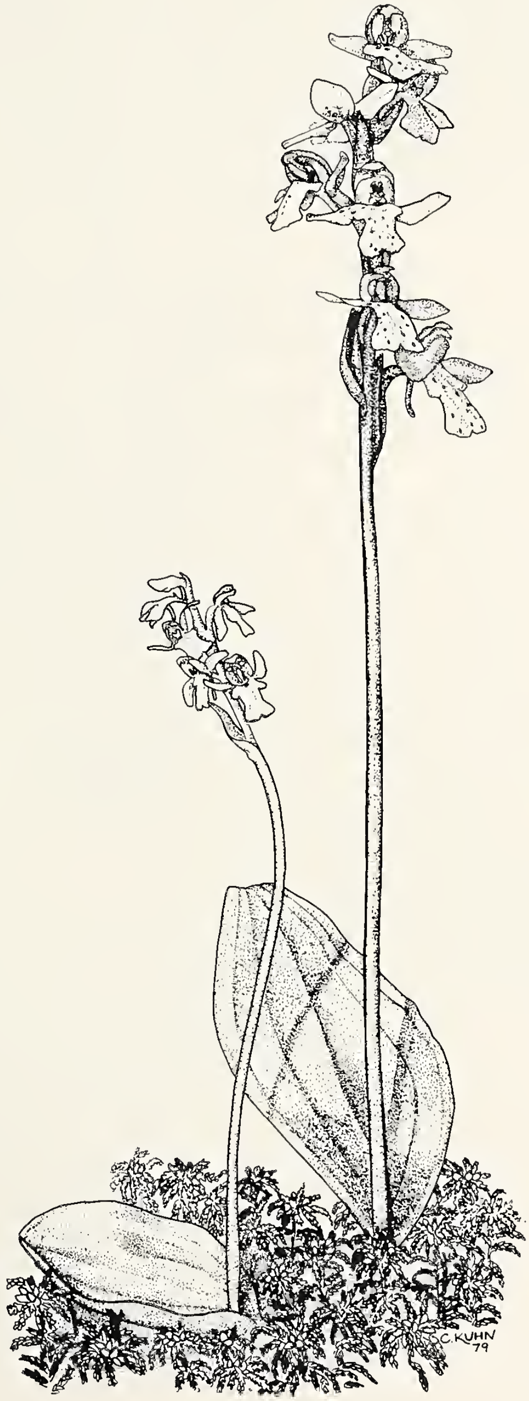
Orchids are popular plants. They possess mystic and exotic qualities and generate considerable excitement when they are found in the wild. As a result, they are avidly sought by orchidists and certain gardeners. Unfortunately, the critical habitat requirements of most species make them, at best, very difficult horticultural subjects, and few species can be successfully cultivated. None of our native species can be reliably grown from seed, and with only a few have even sporadic successes been reported. As a result, horticultural demand is supplied from the wild, and populations decline as a result. Some species are presently more threatened by collection than by any other single factor.

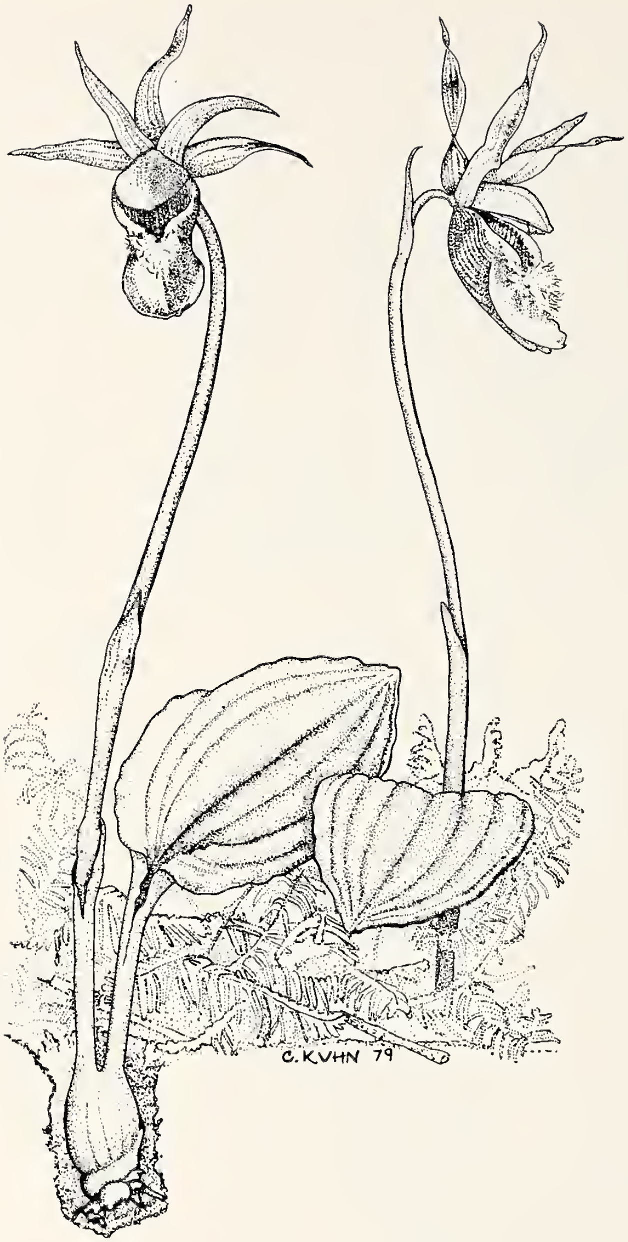
ROUND-LEAVED ORCHIS

Amerorchis rotundifolia (Banks) Hultén

Status:	Possibly extirpated in New York State (X-2)
Rarity:	Transcontinental at high latitudes; extremely rare as far south as the northeastern United States. This species has been found in the State at only two sites, and has not been seen in over one hundred years. Both of the stations for the plant were swampforests now extensively altered by development, so the plants probably no longer occur there. However, much seemingly suitable habitat occurs in other swamps, especially in Herkimer County, and the species may yet be relocated in the State.
Habitats:	Cold, calcareous swamps (in N.Y.).
D.E.C. Region:	6
Counties:	Herkimer, Lewis

The Round-leaved Orchis is a small, single-leaved plant with a few pink and white flowers on a leafless stem. The flowers have flat, pink-spotted, white lips with deep lateral lobes. Other species with lobed, pink and white lips have leafy stems; the Showy Orchis (*Galearis spectabilis*) bears similarly-colored flowers on a leafless stem, but its lips are unlobed, and it has paired leaves.





CALYPSO

Calypso bulbosa (L.) Oakes

Status: Endangered in New York State (E-3)

Rarity: Generally distributed at high latitudes and in cool regions in North America and Eurasia. Calypso is abundant in some portions of its vast range, but is generally very rare in eastern North America. In New York, it has been found only three times in this century (only once in the last 50 years); one of these stations has been destroyed, and the plant has not been seen elsewhere since 1949. Apparently the species was only tenuously established in New York, and was quickly eliminated with changes brought on by development, though it may still be rediscovered here.

Habitats: Swamps, bogs and moist coniferous woods in calcareous soils, especially with Arbor Vitae (*Thuja occidentalis*).

D.E.C. Regions: 4, 6, 7, 8.

Counties: Genessee, Herkimer, Jefferson, Lewis, Oneida, Onondaga, Oswego, St. Lawrence, Schenectady.

Calypso is unlike our other orchids; though it bears a pink and yellow pouch-like lip (resembling the Lady-slippers), there is only a single, smooth leaf at the base of the plant. The leaf is produced in late summer and over-winters; it withers in the spring and is sometimes absent by flowering time.

STRIPED CORALROOT

Corallorhiza striata Lindl.

Status: Endangered in New York State (E-2)

Rarity: Widespread in western North American Mountains; disjunct and rare in upper Great Lakes region and St. Lawrence drainage. A single New York location was verified in 1979. The Striped Coralroot has been recorded at only three stations in New York, and at only one in the last 50 years; the known extant population is a single plant.

Habitat: Moist, mixed coniferous-hardwood forests over limestone, and calcareous swamps.

D.E.C. Regions: 6, 7, 8

Counties: Lewis, Madison, Monroe.

The Coralroots are nongreen, leafless, saprophytic orchids. Striped Coralroot is the largest of the species in our area, often over 1½ feet tall, with flowers nearly an inch across. In contrast, other species bear flowers less than ½ inch across, and often much smaller. In Striped Coralroot the entire plant is bright reddish, and the flowers strikingly striped with white or cream. The New York records of this species come from deep, calcareous swamps, though elsewhere, as in the Great Lakes region, the species occurs primarily in upland woods (sometimes rather scrubby) in thin soil over limestone. It could occur in similar sites in this State.

RAM'S-HEAD LADYSLIPPER

Cypripedium arietinum R.Br.

Status: Threatened in New York State (T-1)

Rarity: A species with rather limited habitat requirements, occurring primarily in the Great Lakes and St. Lawrence regions, this is a generally rare plant throughout its range. The rarity of the Ram's-head and its curious flowers make it a prized garden plant, and the species is commercially exploited in some other northeastern states. It is occasionally dug by individuals, but is rather inconspicuous, and at present its collection does not seem to have been a major problem in New York.

Habitat: Two distinct habitats are occupied in New York, having in common a limestone-rich substrate. The principal habitat, in terms of size of colonies, is open coniferous or mixed forest and scrub over limestone. The species is apparently more generally distributed in calcareous swamp-forests on hummocks, but in such sites the colonies are very small.

D.E.C. Regions: 4, 5, 6, 7, 8.

Counties: Albany, Clinton, Essex, Fulton, Herkimer, Jefferson, Lewis, Madison, Oneida, Onondaga, Oswego, Otsego, Schenectady, Warren, Wayne.

The Ram's-head Ladyslipper is smaller than its relatives, with its pouch forming a downward-projecting cone; it is definitely not slipper-shaped. The white and reddish flowers are further unusual in bearing three separate sepals, whereas in other Cypripediums the lower two sepals are fused behind the pouch. Hence, the Ram's-head bears five slender segments (sepals and petals), while other species have only four.

SMALL WHITE LADYSLIPPER

Cypripedium candidum Muhl. ex Willd.

Status: Endangered in New York State (E-1)

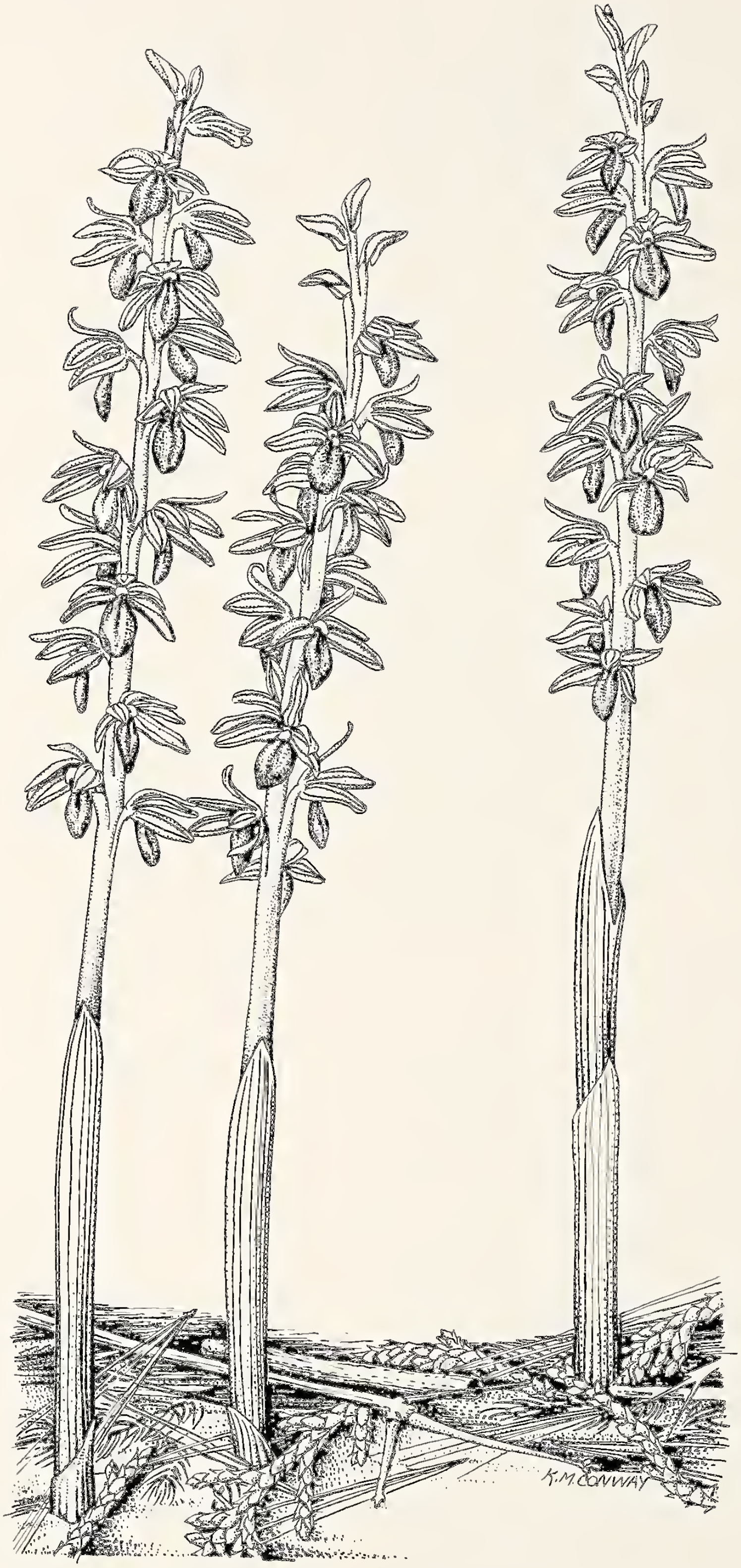
Rarity: A rare, midwestern species scattered locally eastward to the Northeast. In New York, confined to the western and central portions of the State. Only two populations of this species are known to survive in New York. Two others have been destroyed. Both extant populations are threatened with successional change and require active management, including burning, brush-cutting, and/or mowing, to preserve them. The rarity and beauty of the species has made it a prized garden subject, and it is often dug by unscrupulous horticulturists. The plant is very difficult to cultivate, however, and so far impossible to grow from seed. It should never be moved from a wild colony except to prevent its imminent destruction.

Habitats: Calcareous meadows and fens.

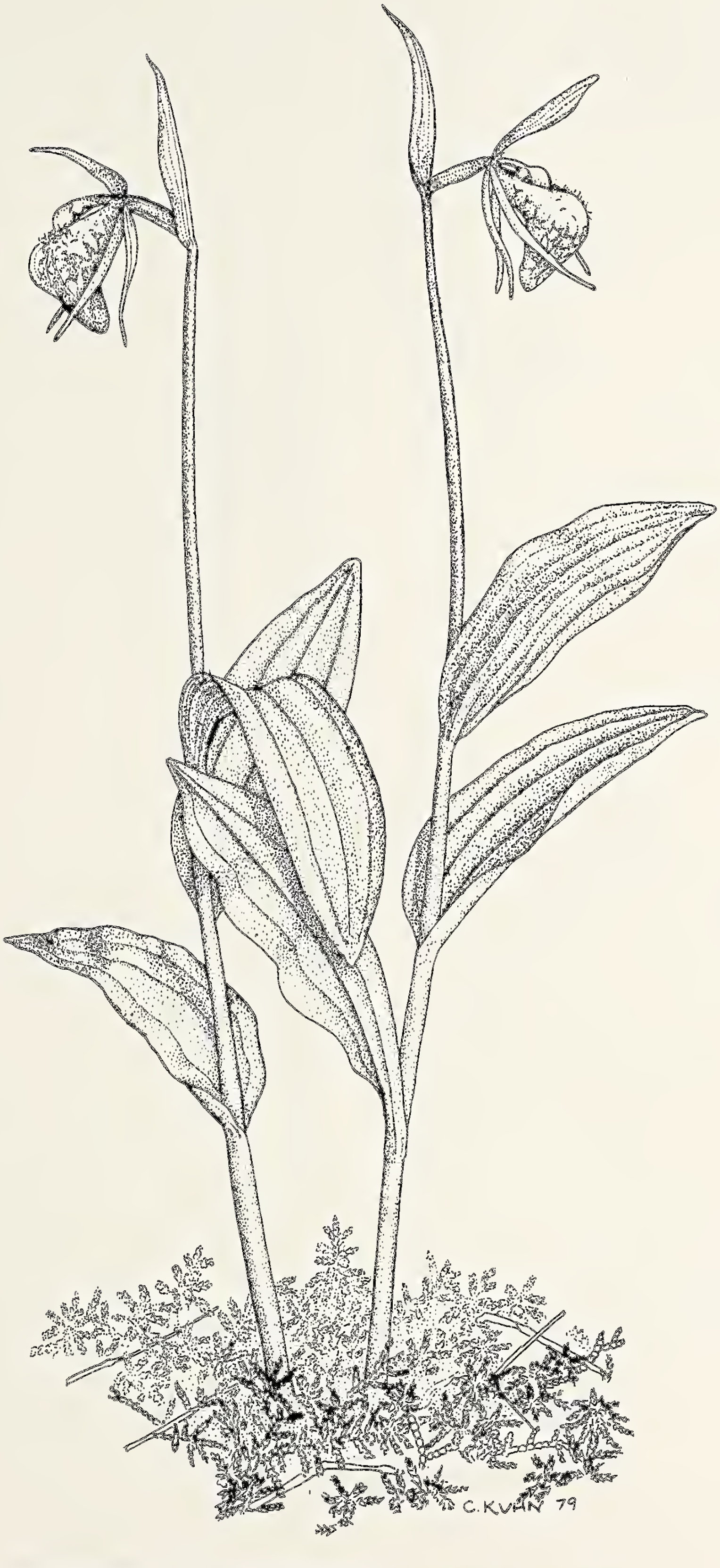
D.E.C. Regions: 7, 8, 9.

Counties: Erie, Genesee, Livingston, Onondaga.

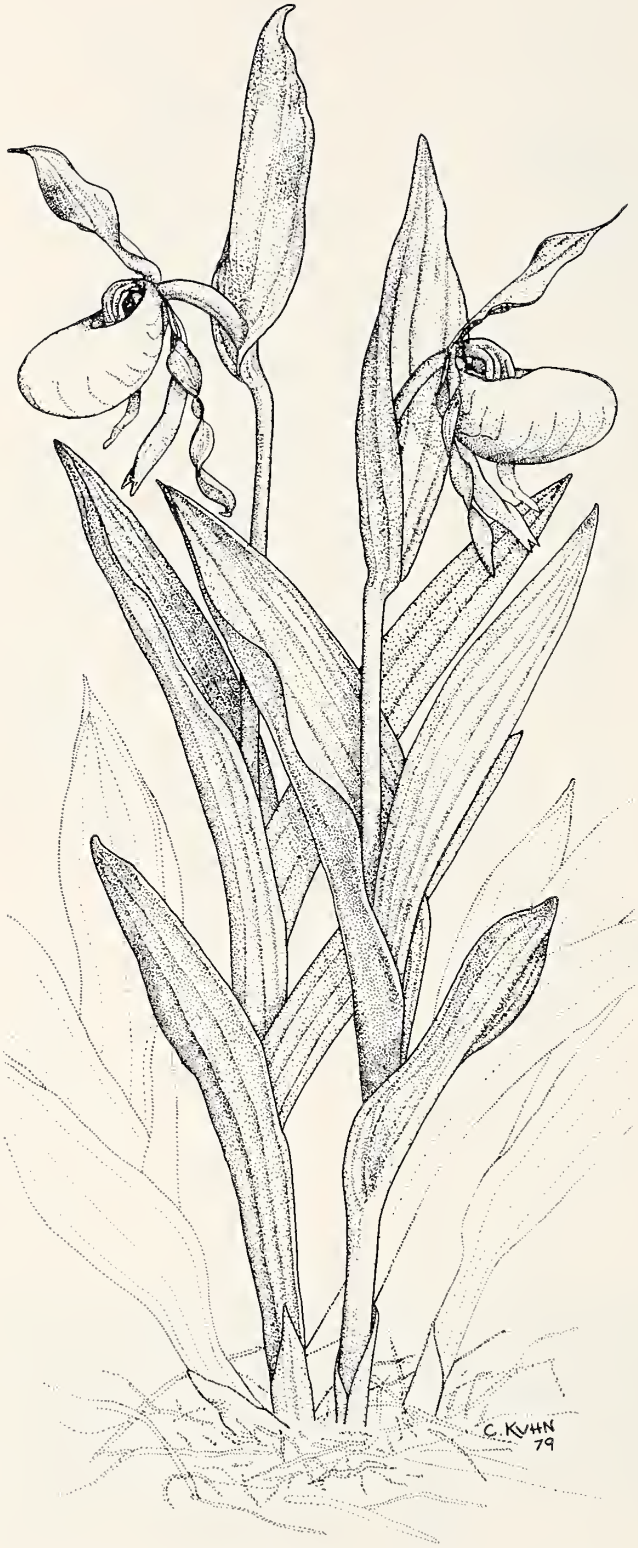
Cypripedium candidum is similar to the more common Yellow Ladyslipper (*C. calceolus*), especially to small-flowered forms of that species. The two species may readily be distinguished by the white lip (slipper) of *C. candidum*, and the yellow lip of *C. calceolus*. In nonblooming plants, *C. candidum* can often be identified by its relatively long leaves, which are commonly



STRIPED CORALROOT *Corallorhiza striata*



RAM'S-HEAD LADYSLIPPER *Cypripedium arietinum*



SMALL WHITE LADYSLIPPER ***Cypripedium candidum***

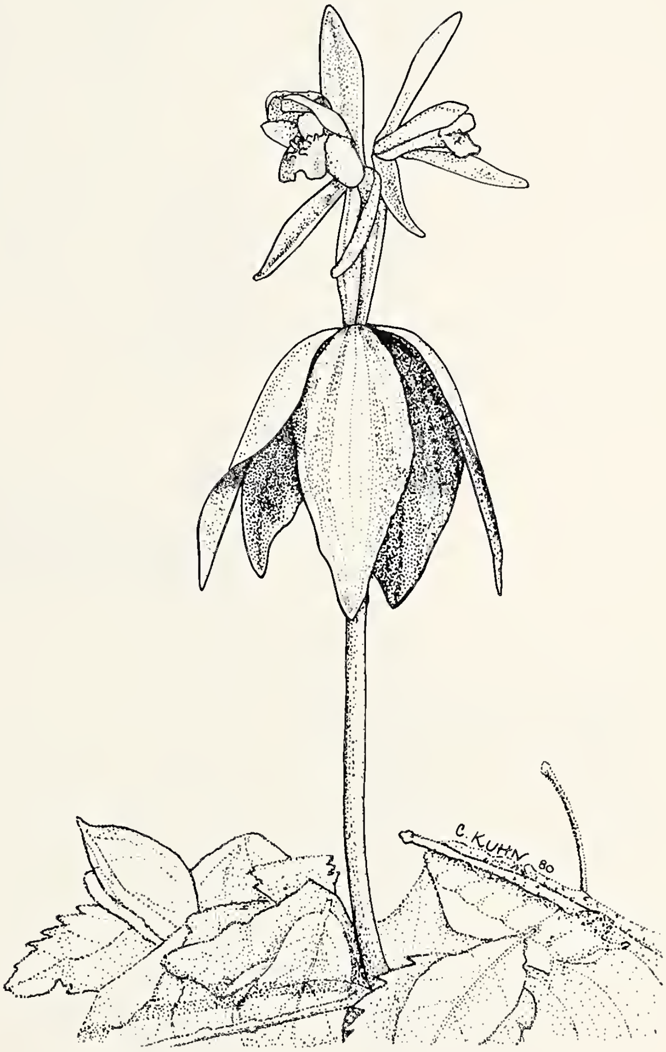
broader toward the tips, borne toward the base of the plant, and directed upward in an ascending cluster; in contrast, the broad leaves of *C. calceolus* generally spread widely and are born at regular intervals along the stem. The Small White Ladyslipper might also be confused with white-flowered plants of the Pink Ladyslipper (*C. acaule*) and with the Showy Ladyslipper (*C. reginae*); the former bears only two basal leaves and does not have the leafy stem of *C. candidum*, and the latter bears broad, flat, white sepals and petals, not the slender greenish or brownish ones of *C. candidum*.

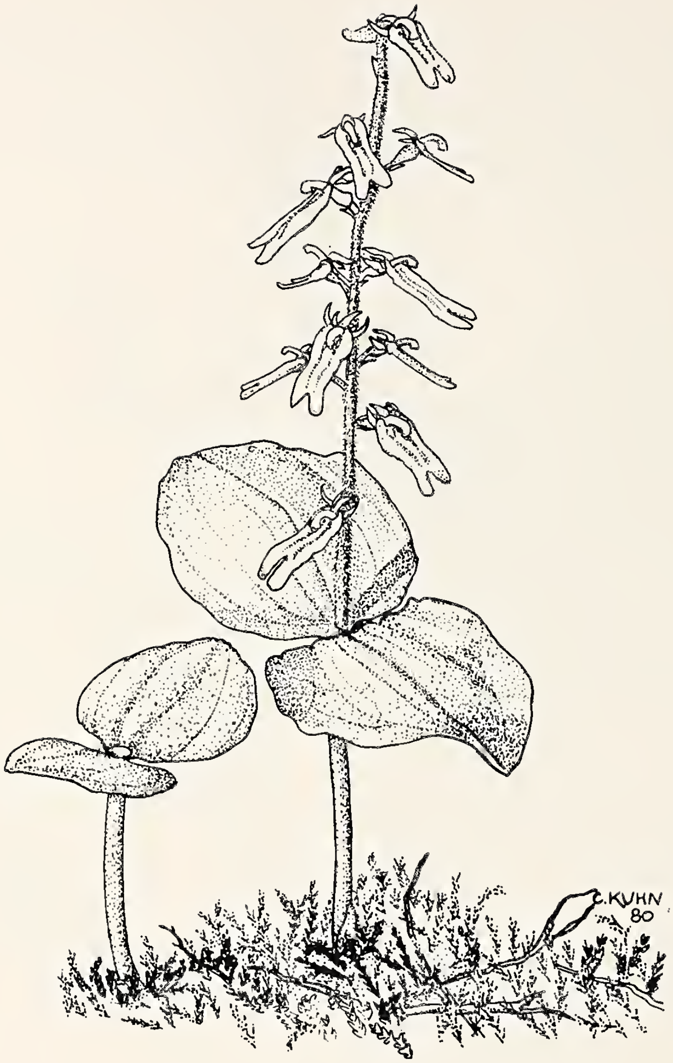
SMALL WHORLED POGONIA

Isotria medeoloides (Pursh) Raf.

Status: Endangered in New York State (E-1) Federally proposed endangered.
Rarity: An exceedingly rare species, sporadically distributed through the easternmost states; also three stations in the Midwest. Only a single New York station has been seen in the last 50 years; in recent years, only a single plant has appeared at this site, on the average appearing every three years.
Habitat: Deciduous or mixed coniferous-deciduous woodland in dry to swampy situations. Often associated with limestone, but sometimes in acidic soils.
D.E.C. Regions: 1, 3, 5, 7
Counties: Nassau, Onondaga, Rockland, Suffolk, Ulster, Washington (all old records except Onondaga County)

The Small Whorled Pogonia, when not in flower, resembles its relative, the Larger Whorled Pogonia *(I. verticillata)*. From this species it is distinguished by its smaller, mostly yellow-green flowers; the larger species has long slender sepals which are darkly stained with purplish-brown. Sterile plants of either of these species closely resemble Indian Cucumber *(Medeola)*, but the stems of the orchids are thick and fleshy, whereas in Indian Cucumber the stems are thin, wiry and often blackish. Sometimes seedling lilies with a single whorl of leaves may also be confused with these orchids. These may be very similar, but become obvious if adult plants can be found in the vicinity. This species does not exhibit any pronounced habitat requirements other than a need for forest cover. Soils range widely in pH, but even in acidic situations calcareous material is usually nearby. These plants are noted for long periods of dormancy, and appear above ground only irregularly. Colonies often fluctuate in apparent size from year to year, and the species may not be evident for years at a time. It is consequently very difficult to locate.





AURICLED TWAYBLADE

Listera auriculata Wiegand

Status: Endangered in New York State (E-1) Federally considered for listing.

Rarity: A rare species of the upper Great Lakes region and eastern Canada, disjunct in northern New York. The Auricled Twayblade is a tiny, inconspicuous plant which is known in New York from two locations, one recently discovered and another from a single collection made over 50 years ago. Many miles of apparently suitable habitat line the streams and rivers of the northern part of the State, however, and it may soon be found again in New York.

Habitat: Thickets at the edges of streams and rivers in alluvial sands and mucky sites, usually on moss under Alders *(Alnus).*

D.E.C. Regions: 5, 6

Counties: Lewis, Warren

This species is one of the true Twayblades, which are characterized by a single pair of leaves born perpendicularly to the stem about half-way up the plant. Only two species of this genus in New York bear flowers with broad, flat lips. The others are slender with forked tips like a snake's tongue. The lip of the Auricled Twayblade has roughly parallel sides, and is generally about as broad at the base as at the tip. At the base, the sides are prolonged into short ear-like lobes which project upward into the center of the flower. Our other broad-lipped species *(L. convallarioides)* bears a wedge-shaped lip which is very much broader at the tip than at the base, and lacks the basal lobes.

CRESTED FRINGED ORCHID

Platanthera cristata (Michx.) Lindl.

Status: Endangered in New York State (E-2)

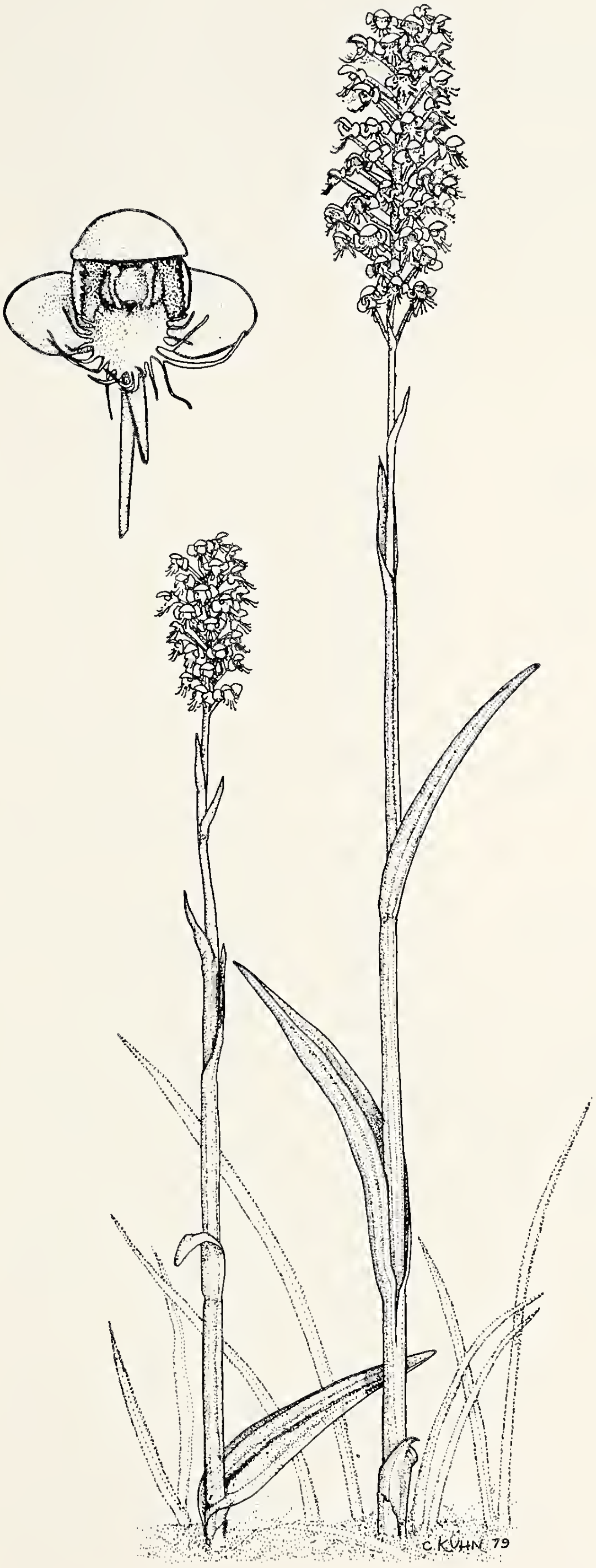
Rarity: A Coastal Plain species more common southward, reaching its northern limit on Long Island. This species occurs in a few open pine-barrens and has been found rarely on wild roadsides. The largest population is threatened with development. All are perhaps threatened by gardeners and other horticulturalists, who would prize this species along with the other fringed orchids.

Habitat: Moist to wet, often boggy, peaty and sandy sites in most of its range. In New York usually moist to rather dry sand under pine litter.

D.E.C. Regions: 1

Counties: Suffolk

The flowers of this species are generally bright orange through most of its range, but in New York can be pale yellow to creamy. Depending on color, it could be confused with either the White Fringed Orchid *(P. blephariglottis)* or Orange Fringed Orchid *(P. ciliaris)*. It is distinct from both in bearing much smaller flowers. The spur is much shorter (less than ¼ inch long) than the lip; in the other species the spur is generally about equal in length to the lip.



PRAIRIE WHITE-FRINGED ORCHID

Platanthera leucophaea (Nutt.) Lindl.

Status: Endangered in New York State (E-1) Federally considered for listing.

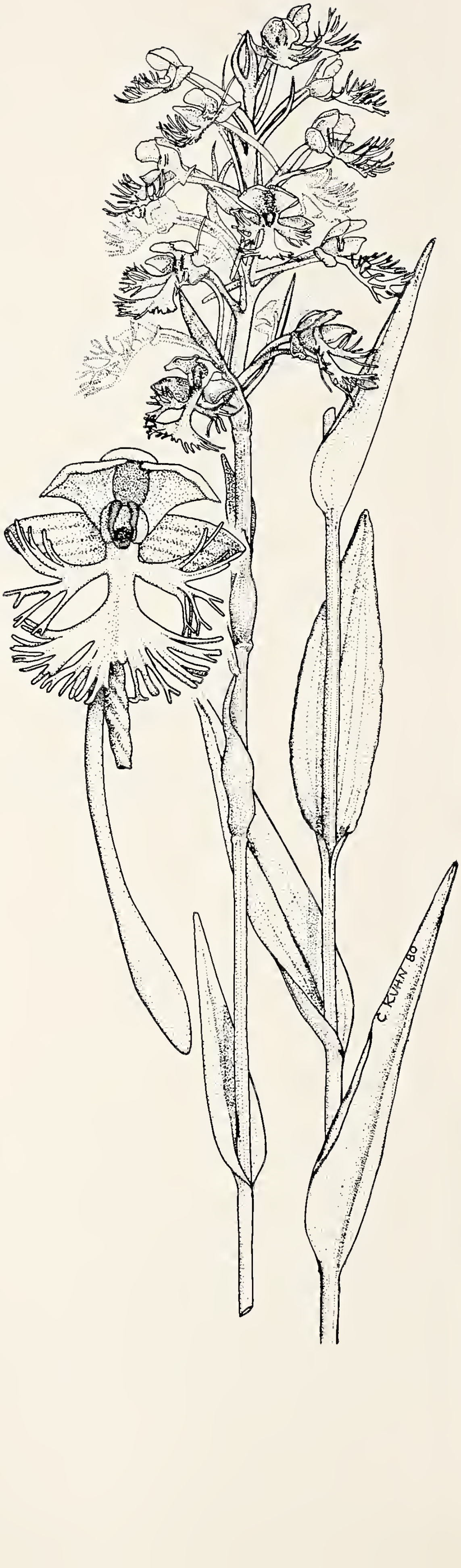
Rarity: This is a very rare species of the prairies and the Great Lakes region where it has been nearly exterminated by development. Always exceedingly rare as far east as New York, it has been reported from only four stations in the State, most recently in 1905. All but one of its stations appear to have been significantly altered in recent years, and the species may no longer occur in New York. One site remains in good condition, however. This species remains dormant for protracted periods, and no plants may be in evidence for several years at a time. Occasionally, however, they may appear in abundance for one or two years, only to seemingly disappear subsequently. This behavior obviously makes locating the species difficult; it may still persist in New York, but will require concerted effort for discovery.

Habitat: Primarily a plant of open, calcareous prairies; in the northeast it occupies open, calcareous bogs, fens, and marshes.

D.E.C. Regions: 7, 8, 9

Counties: Niagara, Onondaga, Oswego, Wayne

The Prairie White-fringed Orchid differs from the more common White-fringed Orchid *(P. blephariglottis)* in bearing a broad lip with three primary lobes, each of which is further divided and fringed. In contrast, *P. blephariglottis* bears a narrower, tongue-shaped lip with a continuous fringe. White-flowered plants of the Purple Fringed Orchids, which bear lips of the same shape as *P. leucophaea*, could be confused with it. The flowers of *P. leucophaea* (about ¾ to 1 inch wide) are much larger than those of the Smaller Purple Fringed Orchid *(P. psycodes)* and about the same size as those of the Larger Purple Fringed Orchid *(P. grandiflora)*. From this last species, *P. leucophaea* is most noticeably distinct in its much longer spur (2-3 times the length of the lip in *P. leucophaea*, versus only slightly longer in *P. grandiflora*).



An Assemblage of Significant New York State Rarities

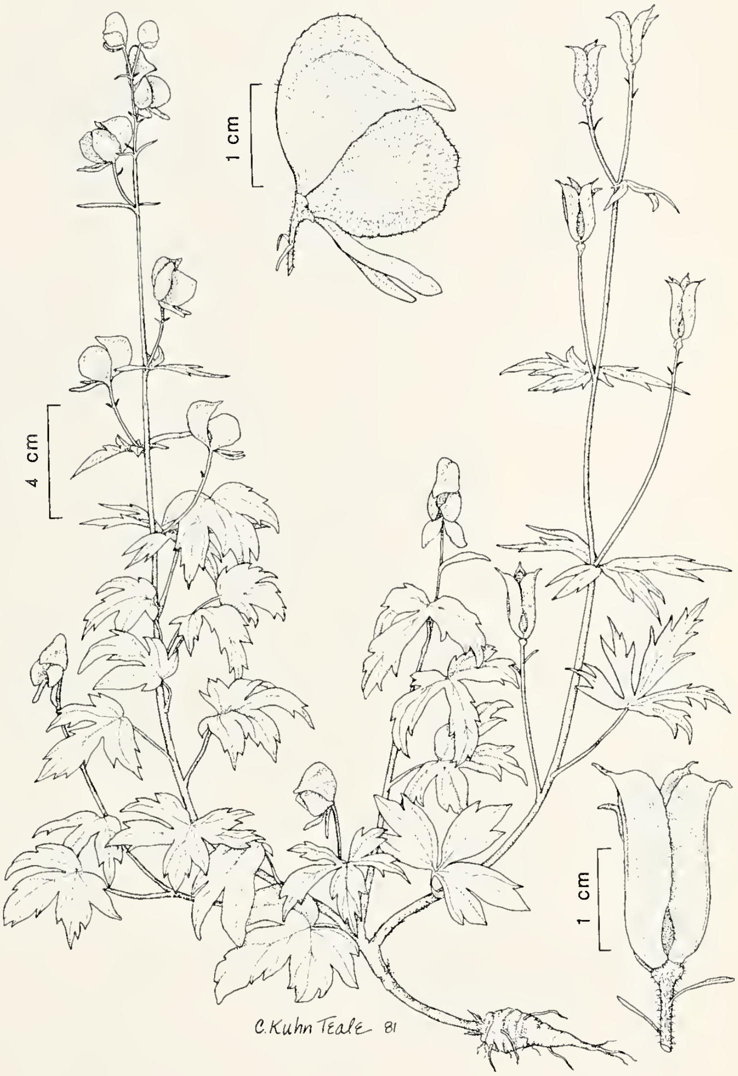
In addition to the rarest ferns and orchids, most of the following species were studied intensively during a period when the botany staff of the New York State Museum was working cooperatively under contract with the U.S. Fish and Wildlife Service. The goal was to obtain current field-status reports containing ecological and demographic data on plants feared to be endangered or threatened in the State. Emphasis was, of course, on species being considered for federal listing, but certain species not listed in the Federal Register were included, as recommended by New York botanists. In some cases field searches revealed enough populations and individuals to discourage federal listing, but with some species threats proved to be critical. For a list of rare and endangered species proposed for protection in New York State, see page 70.

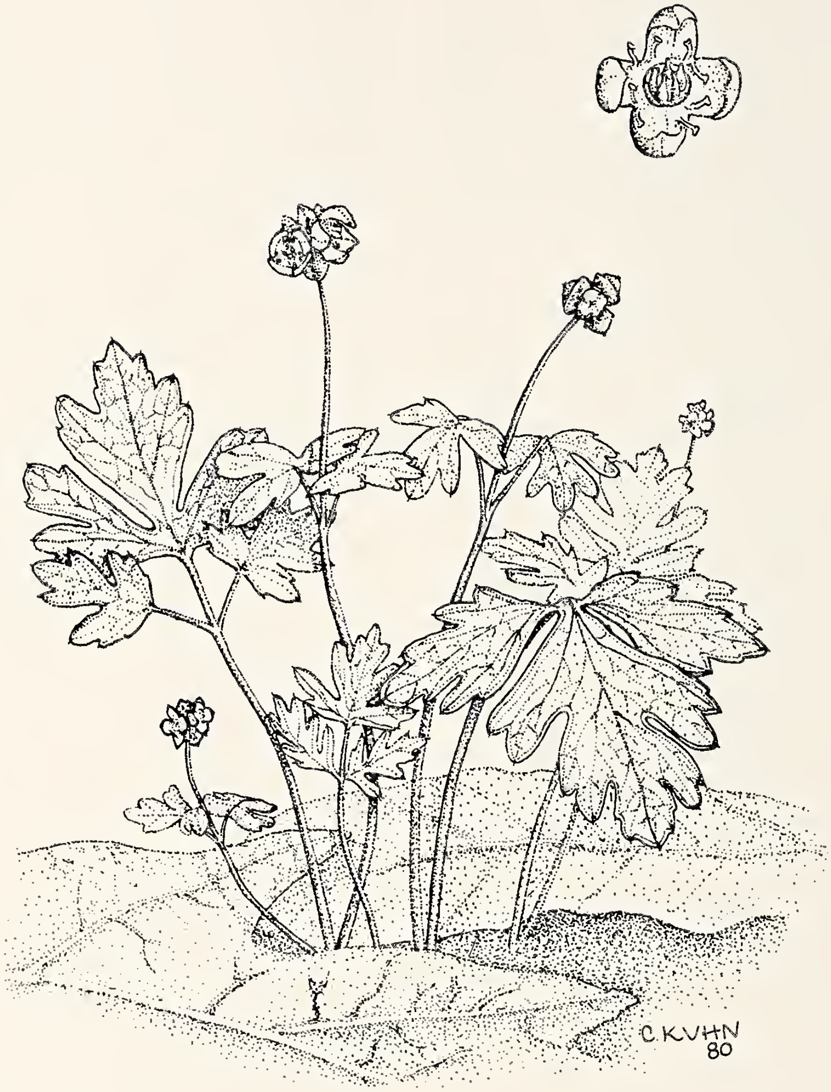
NORTHERN MONK'S-HOOD (Crowfoot Family, Ranunculaceae)

Aconitum noveboracense A. Gray

Status:	Federally listed Threatened; Threatened in New York State (T-1)
Rarity:	This species is known from four states: Ohio, New York, Iowa and Wisconsin. It was originally described from New York State from a site where it no longer occurs. One population was recently partially destroyed by campers, and the largest colony (of some 400 individuals) is vulnerable due to its proximity to a road.
Habitats:	Cold streambeds, mossy banks and talus, gravelly areas, springheads, seeps, rich woods and partial clearings.
D.E.C. Regions:	3, 7
Counties:	Ulster, Chenango

This species is showy and vulnerable because of its horticultural desirability. Plants are often tall and branched, with variable, palmately divided leaves of a type common among Buttercups. Flowers are purple, up to an inch high and helmet-shaped with cap-like hoods (Cover and page viii). They are not likely to be confused with other wildflowers in New York, since their nearest relatives are found to the south and west. In our area they most closely resemble cultivated European Monk's-hoods and garden Delphiniums. When not flowering, Monk's-hoods may be told from most Buttercups by the lack of pale, yellow blotches near the cuts of their leaf margins. The leaf stalks of Buttercups also collapse when squeezed, while those of Monk's-hood do not.





MOSCHATEL (Moschatel Family, Adoxaceae)
Adoxa moschatellina L.

Status: Threatened in New York State (T-3)

Rarity: This is primarily a Eurasian plant, but it has a spotty distribution from Alaska to the southern Rockies, Iowa, Minnesota and Wisconsin. Its occurrence in the New York Catskills is nearly a thousand miles from the rest of its range, and represents a striking case of disjunction.

Habitats: Woodlands in rich humus, often on ledges, frequently associated with lime-rich rocks.

D.E.C. Region: 4

Counties: Delaware, Greene

These small plants have leaves divided and lobed in threes and are easily mistaken for Wood Anemone (*Anemone quinquefolia*) or seedlings of other plants when not flowering. Flowers are small and greenish-yellow with 4 or 5 petals. They are borne in a dense cluster at the tip of a slender,purplish stalk.

GERARDIA ("False Foxglove") (Figwort Family, Scrophulariaceae)

Agalinis acuta Pennell

Status: Endangered in New York State or possibly extirpated (X-1); Federally considered for listing.

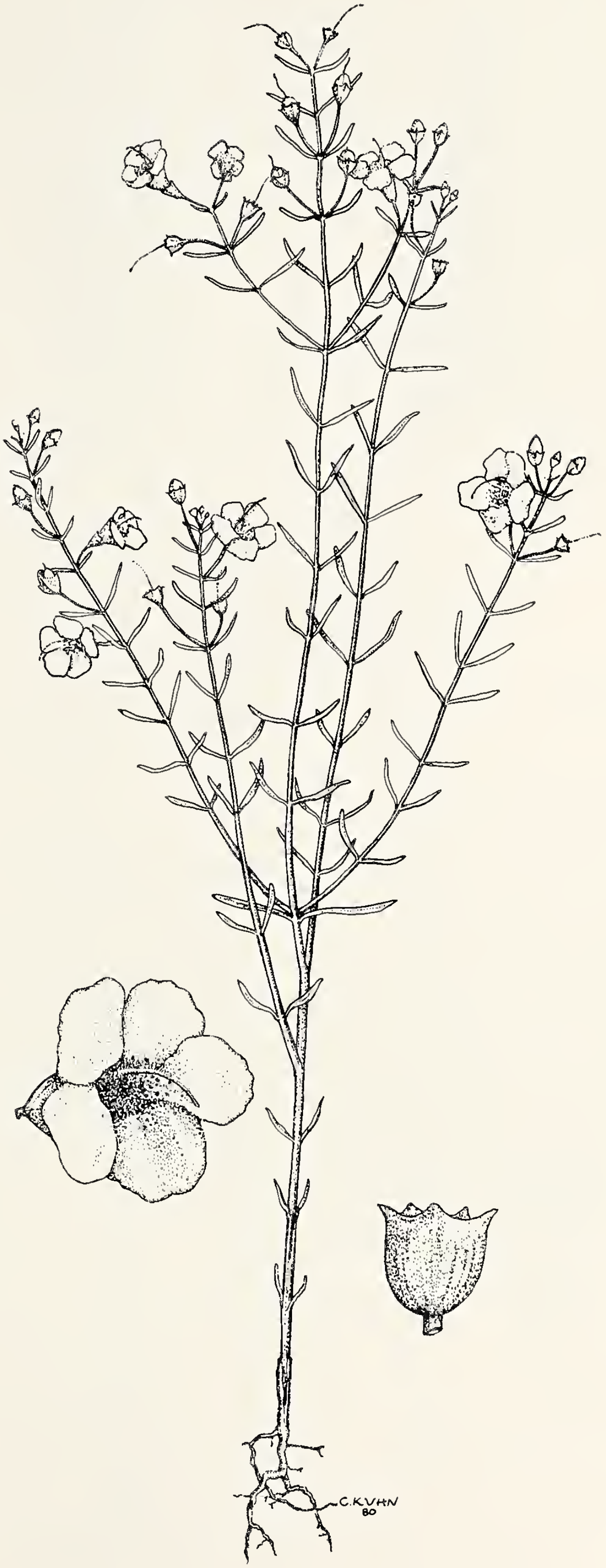
Rarity: This is a rare species of open meadow and grassy downs on Cape Cod and Long Island. It has been found in the past at a number of stations on Long Island, but most of these have been overgrown or cleared. The species seems to have been concentrated at the eastern and western ends of the island; in the west it occurred on the Hempstead Plains, and its stations have been completely destroyed by development; in the east, successional change of the open Montauk Downs to scrub and woodland seems to have eliminated the species. Although it possibly persists in low numbers, it has not been found in the State in the last fifty years.

Habitat: Dry, open meadows and downs

D.E.C. Region: 1

Counties: Nassau, Suffolk

Agalinis acuta is one of a group of showy-flowered, slender-leaved plants commonly called Gerardias. Distinctions between species are in small details of the calyx and in the length of the stalks of the individual flowers. In *A. acuta* and some of its relatives, the calyx is composed of five small, slenderly triangular (rather than roundish) greenish lobes at the base of the flower. The pedicels of the flowers in this species are distinctly longer than the calyces (rather than shorter). From the few other species with this combination of characteristics, *A. acuta* is distinct in displaying a finely reticulate pattern of veins on the calyx; the other species show no obvious venation. Plants are pale green in color.



CUT-LEAVED ANEMONE (Crowfoot Family, Ranunculaceae)

Anemone multifida Poir.

Status: Probably extirpated in New York State (X-3)

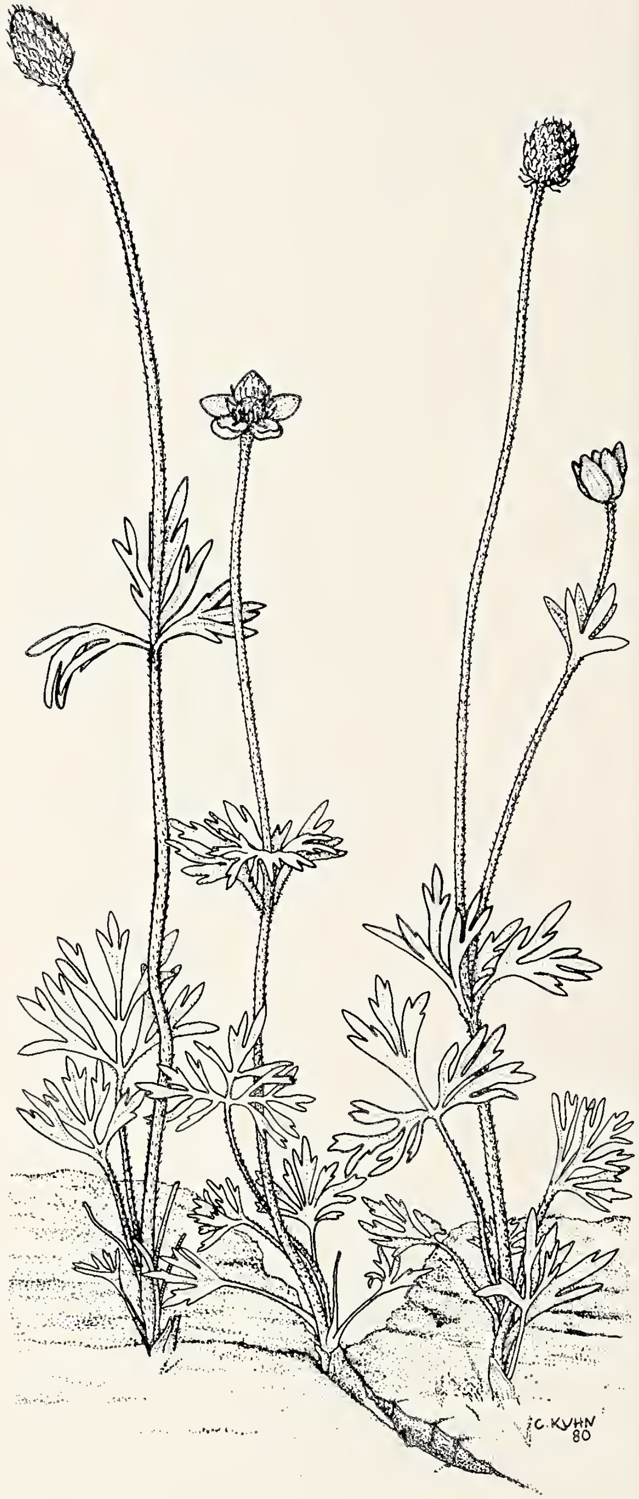
Rarity: This is a wide-ranging species with many varieties. In eastern North America it reaches its southern limits in Maine and Vermont (foremerly New York). It also ranges to Alaska and South America.

Habitats: A wide range of open, rocky places; found on steep, limestone riverbluffs in New York and Vermont.

D.E.C. Region: 6

County: Jefferson

Cut-leaved Anemone differs from other native species in having leaves cut into many lance-shaped lobes. There are usually only one or two flowers borne on slender stalks. Fruit are borne in a woolly, oval head. These plants have been sought intensively in the area where they once grew and are now feared extirpated. The riverbanks where they once were found with Prairie Smoke (*Geum triflorum*) have been much-disturbed by industrialization, and both species probably succumbed to water level rises after extensive dam building in the 19th century. Neither has been reported since the 1860's.

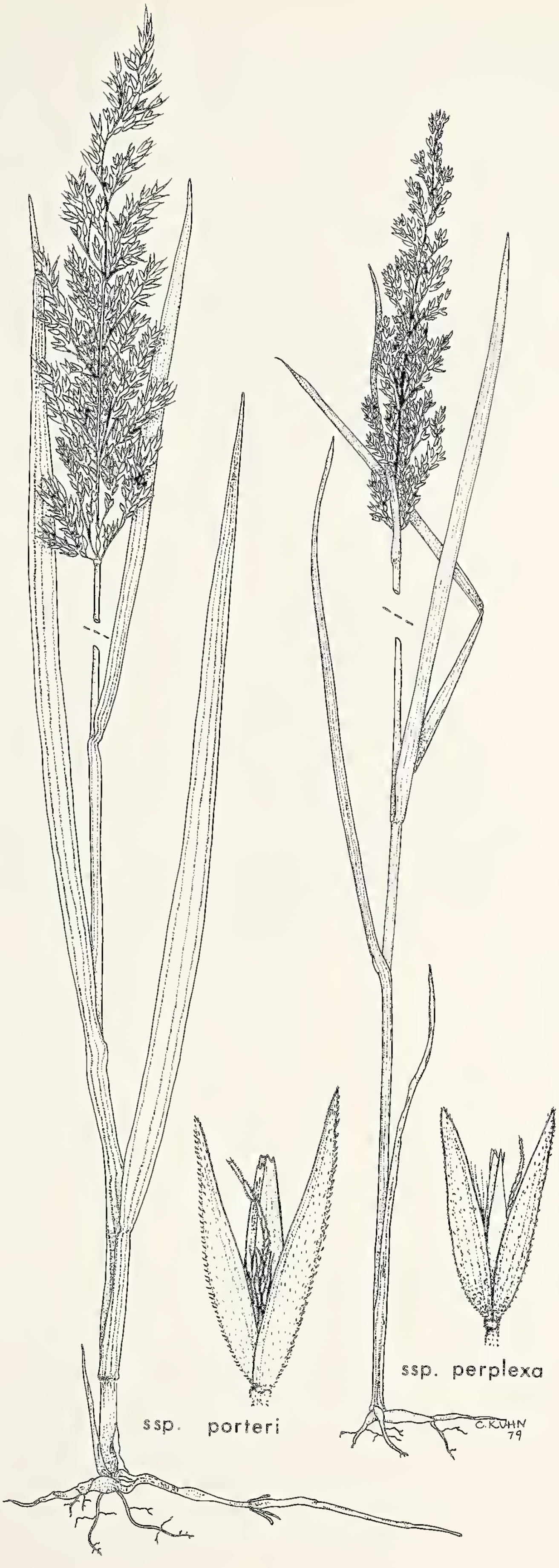


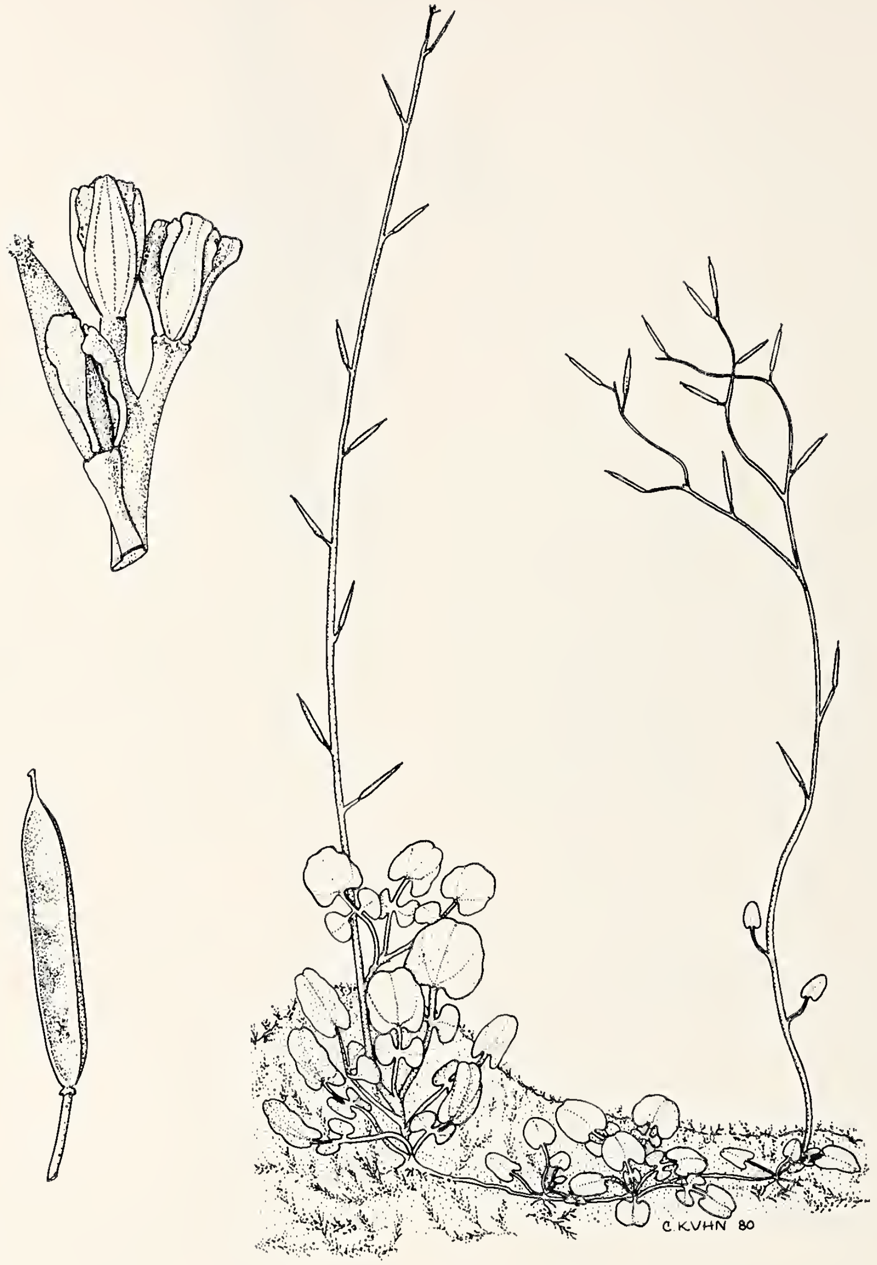
PORTER'S REEDGRASS (Grass Family, Poaceae)

Calamagrostis porteri A. Gray

Status: Threatened in New York State (T-3)
Rarity: Once thought to be rarer than it is, this Reedgrass remains an uncommon, Appalachian species, reaching its northern limits in New York State. Its very rare subspecies *perplexa* is only found in New York, and only in a single verified location.
Habitats: Dry, upland woods and slopes
D.E.C. Regions: 7, 8
Counties: Chemung, Steuben, Tioga, Tompkins

This grass is listed here as an example of a relatively uncommon species which was rejected for federal listing (as threatened) after being sought out and studied in the field. The typical variety is known from Kentucky, New York, Pennsylvania, Virginia and West Virginia, while subspecies *perplexa* is known from a single locality in Tompkins County, New York. Subspecies *perplexa* is listed as a full species by some authors and differs from var. *porteri* in its chromosome number and in having smaller florets and flower parts.





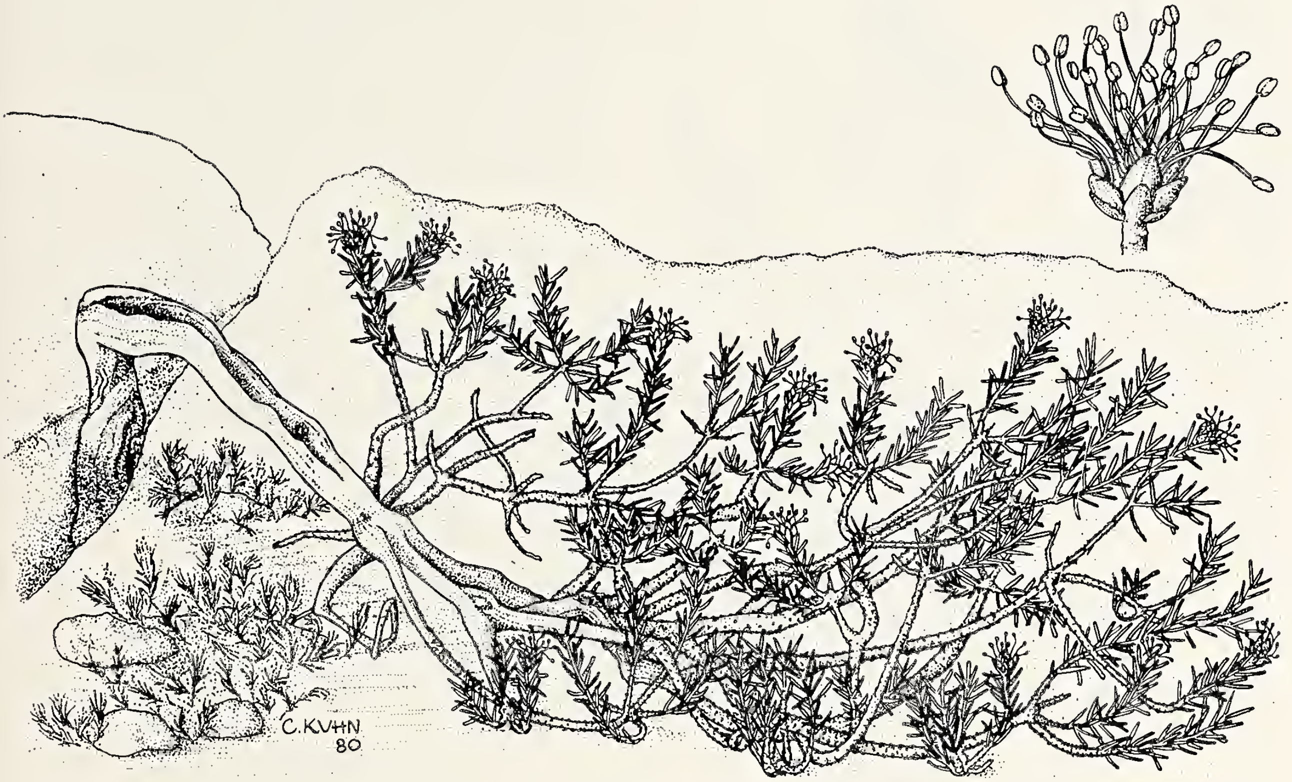
LONG'S BITTERCRESS (Mustard Family, Brassicaeae)

Cardamine longii Fern.

Status:	Threatened in New York State (T-1) Federally considered for listing.
Rarity:	This rare and sporadically distributed plant is found in coastal areas of Maine, New York, Maryland and Virginia. It is small and easily overlooked, and should be sought all along the eastern seaboard.
Habitats:	Muddy banks and shores of estuaries

D.E.C. Region: 1
County: Suffolk

The foliage of these inconspicuous plants may be lobed and toothed, much like other small members of the Mustard Family, but most leaves are unlobed or only 2–3 lobed. An added discouragement to their detection is the lack of any showy flower parts. The petals are so minute and drop so early that the botanist who originally described the species claimed that it lacks petals.



BROWN CROWBERRY, BROOM CROWBERRY (Crowberry Family, Empetraceae)

Corema conradii Torr.

Status: Endangered in New York State (E-3)

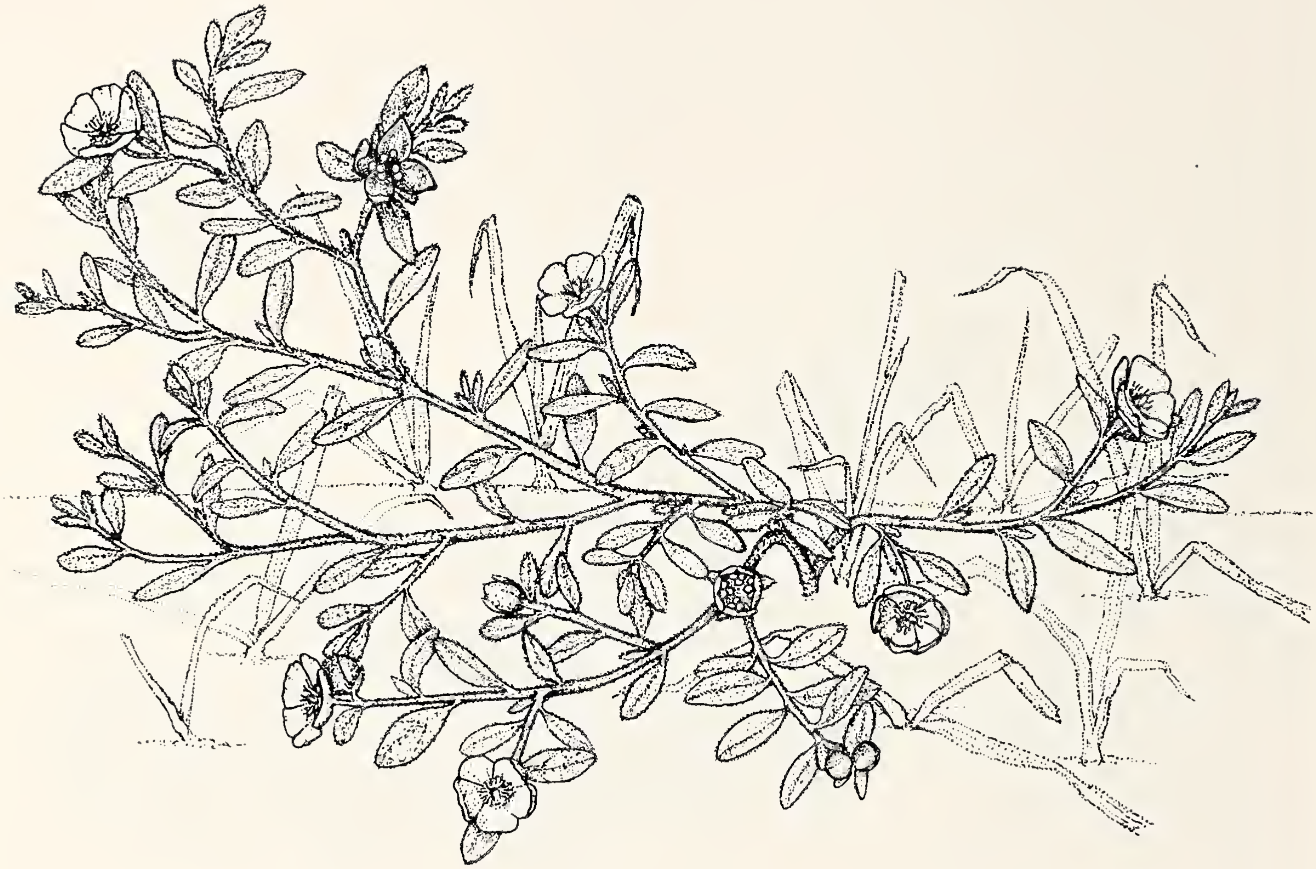
Rarity: A northern, coastal species becoming rare and sporadic southward to New Jersey.

Habitats: This species occurs primarily along the coast in exposed, sandy soils. In New York, however, the only known population is on an exposed lip of a cliff. The plants here are very low-growing and mat-forming; they are threatened by recreational use of the area, and portions of the colony have been destroyed by trampling. The species has also been reported from Suffolk County, Long Island.

D.E.C. Region: 3

County: Ulster

The Brown Crowberry is a small shrub with slender evergreen leaves which appear needle-like because their margins curl under. Clusters of male flowers, evident primarily as bunches of long purplish stamens, are born at the tips of the branches in early spring. Fruiting plants are rare in the New York State population. The plants might be mistaken for young, prostrate spruces.

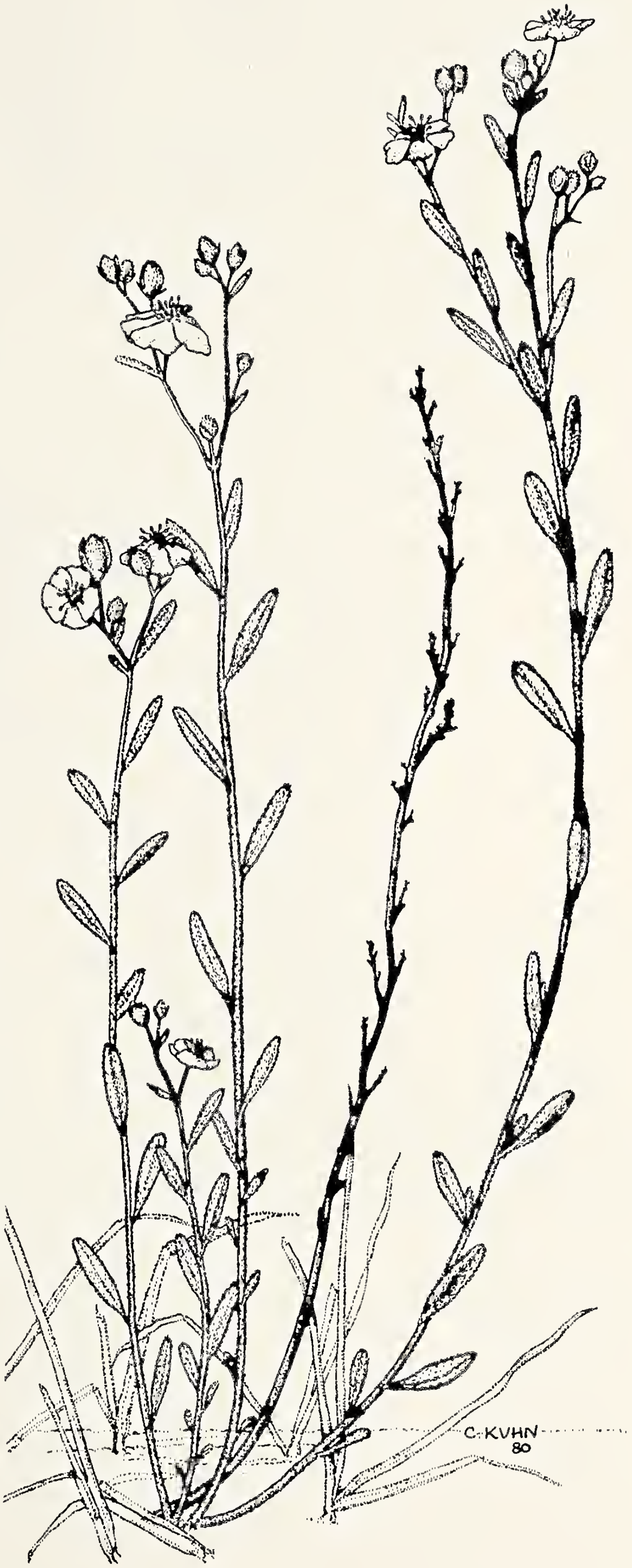


BUSHY ROCKROSE, FROSTWEED (Rockrose Family, Cistaceae)

Helianthemum dumosum (Bickn.) Fern.

Status:	Endangered in New York State (E-1) Federally considered for listing.
Habitats:	Dry, open meadows, downs and barrens; sedge mats under oaks.
Rarity:	Restricted to the coastal area from Long Island to Eastern Massachusetts. *Helianthemum dumosum* is known from only a few stations throughout its range. In New York it has not been reported from Nassau County in over fifty years, and, considering the development of the area, it probably does not occur there at present. Other populations toward the eastern end of the island may have fared a little better, but extensive development and successional change of the open downs to scrub and thickets have eliminated much habitat. Only three populations are presently known to persist.
D.E.C. Region:	1
Counties:	Nassau, Suffolk

Two very rare Frostweeds occur in New York and are easily confused with common species; for convenience, both *Helianthemum dumosum* and *H. propinquum* (the following species) will be discussed here. Helianthemums produce two types of flowers: early in the season large, showy, yellow, petal-bearing flowers are produced; these are followed by small, brownish, inconspicuous, closed (cleistogamous) flowers. In both the rare species and the common *H. canadense*, the sepals of the petaliferous flowers are of two distinct lengths, whereas in another species, (*P. bicknellii*) they are all about the same size. The sepals of these three species all bear star-shaped, branched hairs; *H. dumosum* and *H. canadense*, but not *H. propinquum*, also bear long, straight hairs. Typically *H. canadense* produces only a single petal-bearing flower (rarely two) which is followed abruptly by cleistogamous ones. In contrast, *H. dumosum* produces a succession of petal-bearing flowers (which may gradually be reduced during the late season to cleistogamous ones). Both *H. canadense* and *H. propinquum* are upright-growing plants, whereas *H. dumosum* is low, profusely branched and spreading.



HOARY FROSTWEED (Rockrose Family, Cistaceae)
Helianthemum propinquum Bicknell

Status:	Possibly extirpated from New York State (X-2)
Habitat:	Dry, open meadows
Rarity:	A coastal species, occurring from eastern Massachusetts to Maryland. This species has been found in New York only in the vicinity of Hempstead, Long Island, and has not been seen since 1925. The extensive development of this area since that time has probably eliminated it from the State, but it should be sought in dry open fields in the area.
D.E.C. Region:	1
County:	Nassau

For separation from other species, see above with *H. dumosum*.

FEATHERFOIL (Primrose Family, Primulaceae)
Hottonia inflata Ell.

Status: Threatened in New York State (T-2)

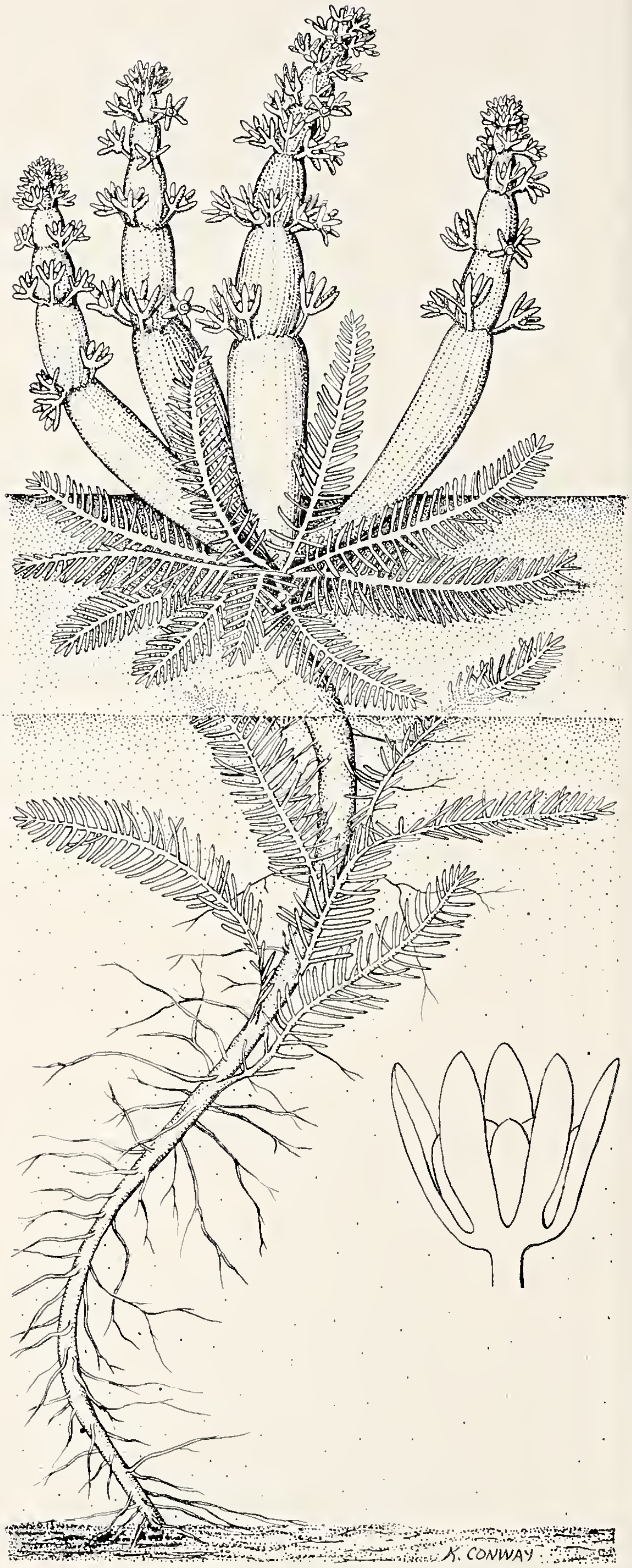
Rarity: This is an aquatic plant which has a wide distribution in the eastern and midwestern U.S., but it is ephemeral. It has been known from many locations where it no longer occurs and may be considered rare and vulnerable.

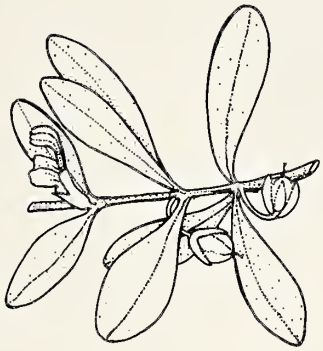
Habitats: Usually shallow water (up to 4 feet) or stranded on mud. If in water the lower stem is submerged with upper, flowering stalks inflated and floating at the surface.

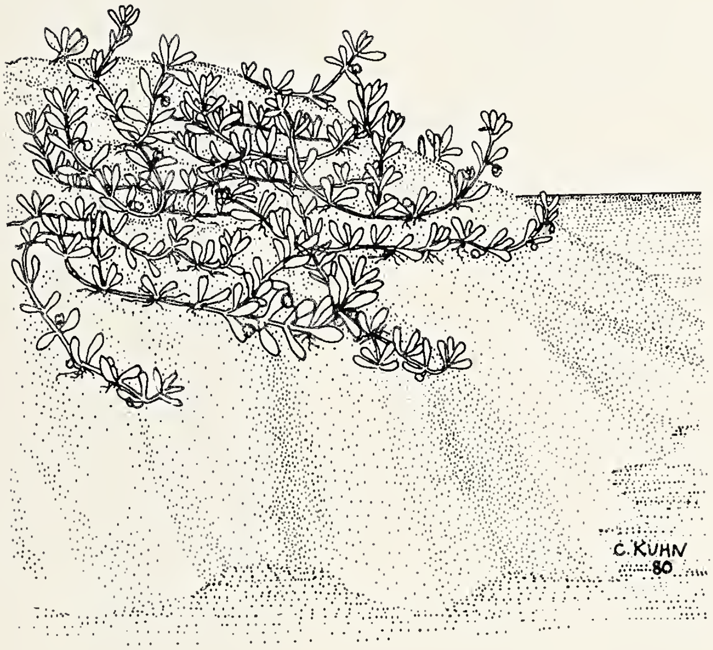
D.E.C. Regions: 1, 2, 3, 6

Counties: Jefferson, Nassau, Richmond, Rockland, Suffolk (all 19th century records except Rockland and Suffolk Counties)

This is a very unusual looking plant which is not easily confused with others. Its underwater leaves are comb-like, resembling those of Water Milfoil (*Myriophyllum*), but the emerging stalks are greatly inflated and constricted at the joints, bearing small, white flowers.







MICRANTHEMUM (Figwort Family, Scrophulariaceae)
Micranthemum micranthemoides (Nutt.) Wettst.

Status:	Endangered in New York State (E-1) Possibly extinct. Federally considered for listing.
Rarity:	This is a species which may be extinct. Though it has been reported from six states and the District of Columbia, recent government-sponsored searches have not turned it up. The Hudson River estuary still holds the best prospects for harboring these tiny plants.
Habitats:	Estuary margins, muddy seepage banks and tidally influenced pools in shallows; fresh to slightly brackish water

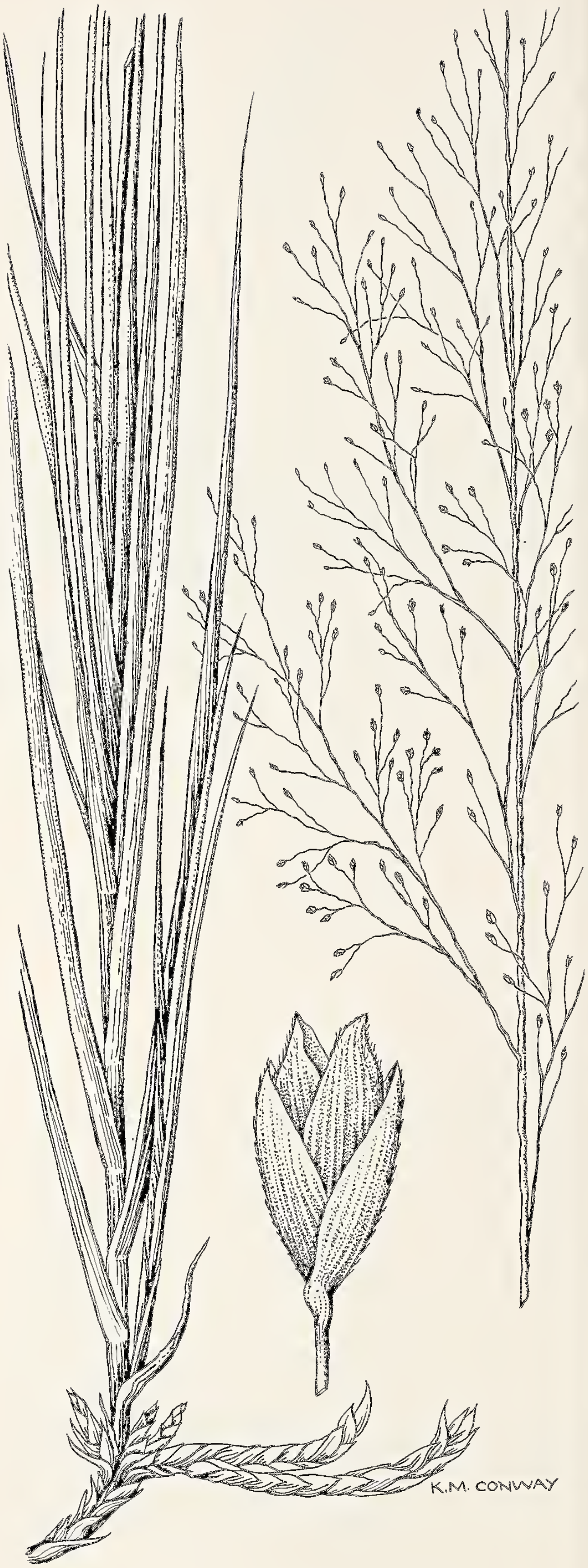
D.E.C. Region: 3
County: Dutchess

Micranthemum is a tiny plant which grows in and around estuaries in a zone which is both unpleasant and dangerous to humans. In some areas strong tides constantly change the configuration of the mud banks and pools, such that *Micranthemum* may be covered up and/or migrate from place to place. It is a thread-like plant with spoon-shaped to oval leaves in pairs or threes. Flowers are whitish and inconspicuous and often drop before opening. The fruit is a tiny capsule borne on a slender stalk. When not flowering, these plants could easily be confused with species of Water Star-grass (*Callitriche*) or other small aquatics.

TORREY'S MUHLY (Grass Family, Poaceae)
Muhlenbergia torreyana (Schultes) Hitchc.

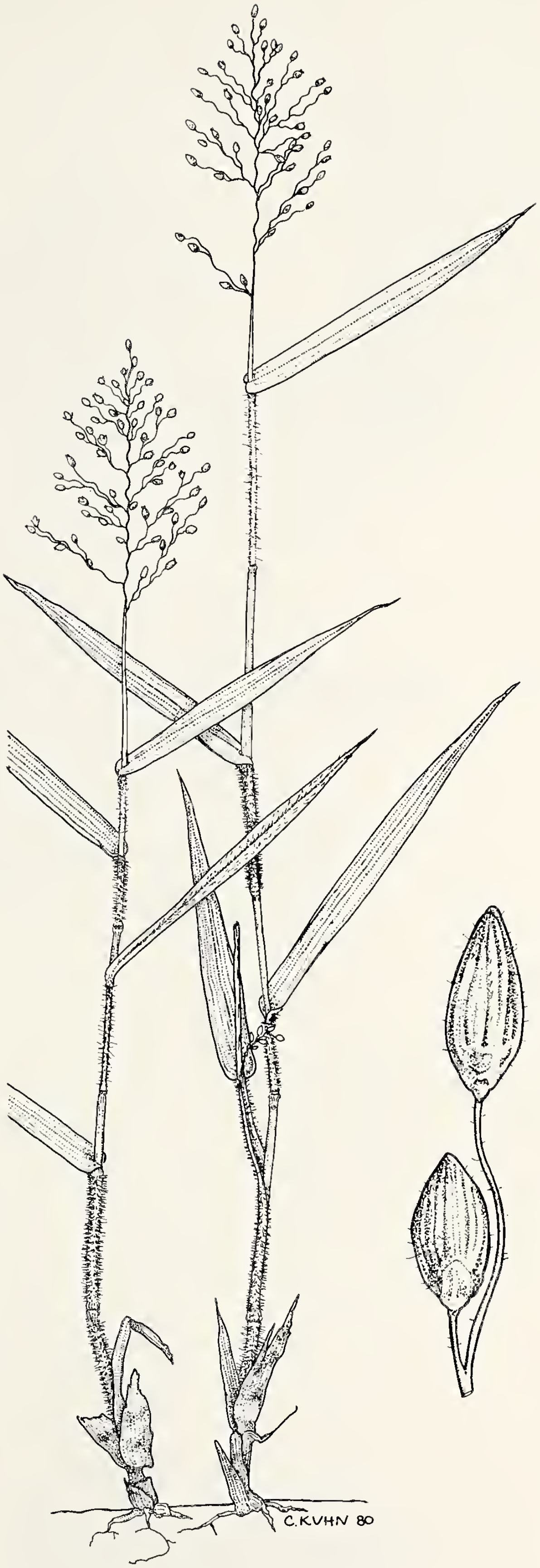
Status:	Endangered in New York State (E-2) Federally considered for listing.
Rarity:	This rare grass is distributed sparingly along the eastern seaboard in Delaware, New Jersey, New York and in Tennessee (formerly Kentucky and Georgia). It is apparently rare throughout its range, and is known from only a single site on Long Island in the 1830's. It is possibly extirpated in New York State, but might easily have been overlooked, and is to be sought in Suffolk County.
Habitats:	Moist, peaty places in pine-barrens
D.E.C. Region:	1
County:	Suffolk

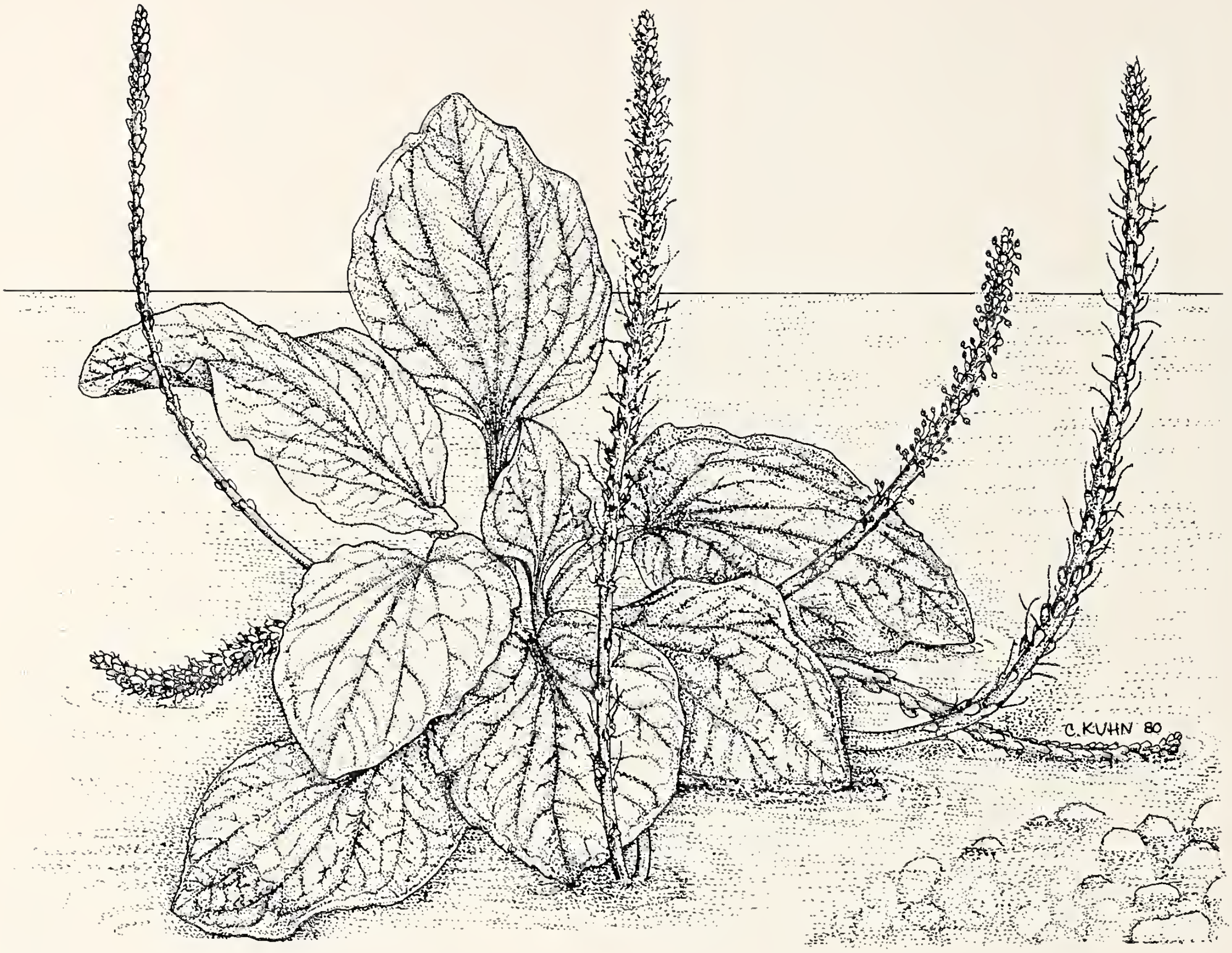
Not to be confused with Ring-grass (*M. torreyi*), this species is most closely related to western Muhlies such as Scratchgrass (*M. asperifolia*). The inflorescence of *M. torreyana* is an oblong, open panicle, and the leaf sheaths are compressed and keeled. A species in the northeastern United States with which it may be confused is *M. uniflora*, which differs in having shorter outer floral parts and longer ligules.



(PANIC GRASS) (Grass Family, Poaceae)
Panicum scabriusculum Ell.
Status: Threatened in New York State (T-3)
Rarity: Rare, southeastern Coastal Plain species very rare in the Northeast. Northeastern populations of this species have frequently been treated as a distinct species (*P. aculeatum* Hitchc. & Chase). As such, the plants were under consideration for listing in the federal level, but the taxonomic complexity of the group made determinations of rarity difficult. The northeastern *P. aculeatum* is now considered to represent the more northern populations of the essentially southeastern *P. scabriusculum;* the species is still rare, but not truly endangered nor threatened enough for federal listing
Habitats: The plant occurs in sandy soils, primarily along the coast. It is disjunct inland in the vicinity of Oneida Lake. It has not been reported in New York in over fifty years, and is doubtless largely extirpated on Long Island.
D.E.C. Regions: 1, 2, 6, 7
Counties: Nassau, Oneida, Oswego, Queens

Panicum scabriusculum is a stout, broad-leaved plant about one to two feet tall. Its leaf-sheaths are pubescent with long, spreading hairs. The large (about ⅛ inch long) flowers and fruits are born in compact, branched clusters. The genus *Panicum* is very complex, and any specimens possibly referable to this species should be carefully determined or sent to a specialist for study.





HEARTLEAF PLANTAIN (Plantain Family, Plantaginaceae)
Plantago cordata Lam.

Status: Threatened in New York State (T-1) Federally considered for listing.

Rarity: This species is reported from ten states, from Wisconsin south to Alabama and Georgia, but it is quite rare in all but Missouri and New York State. In New York the plants are known from a 120-mile stretch of the estuarine Hudson River, mostly in populations of a few individuals. Most populations have probably seeded in down-river from the one thriving colony of about 3,000 plants. If this colony were destroyed, the future of the species in the Hudson would be doubtful.

Habitats: Gravelly and mucky river and streambanks, usually in shade of forest areas or on their borders; plants may be under fresh or brackish tidal influence and may be submerged for part of each day.

D.E.C. Regions: 2, 3, 4

Counties: Albany, Bronx, Columbia, Dutchess, Greene, New York, Ulster

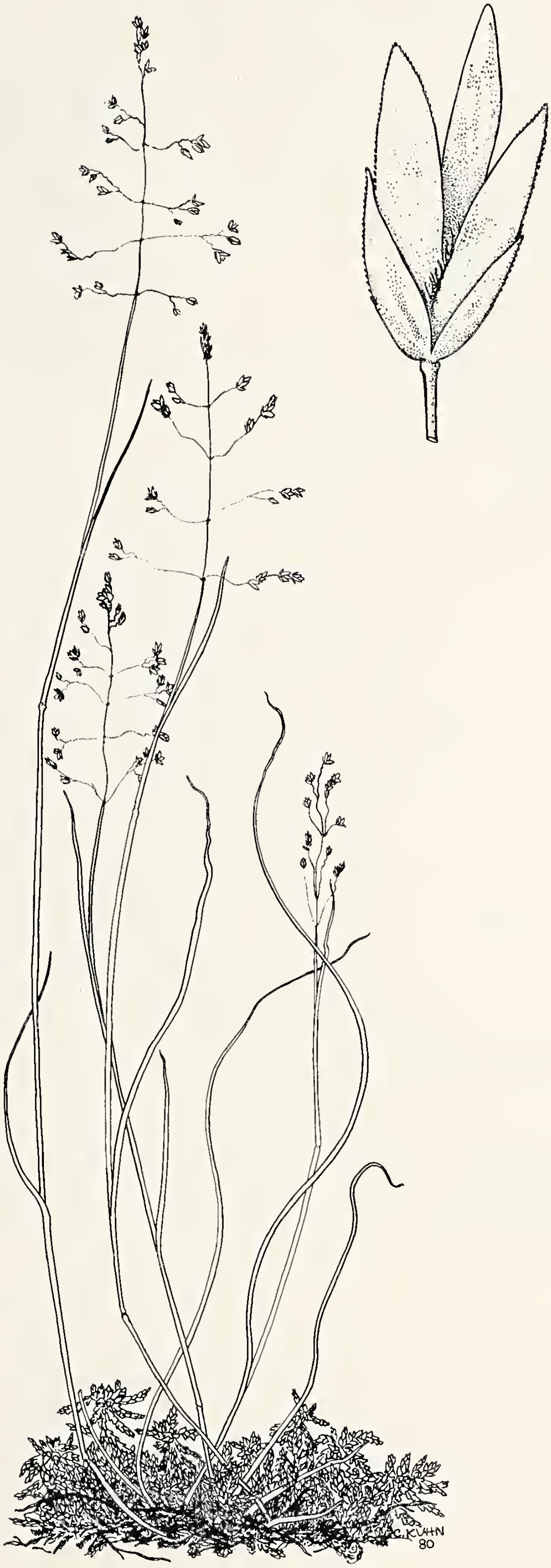
This species bears some superficial resemblance to the Common Plantain (*P. major*), but it is larger and grows in wet, often shady habitats. The broad leaves have stong midveins with some lateral veins branching from them, rathar then a series of nearly equivalent convergent veins. Flowers are small, pale and numerous over most of the length of slender, arching stalks.

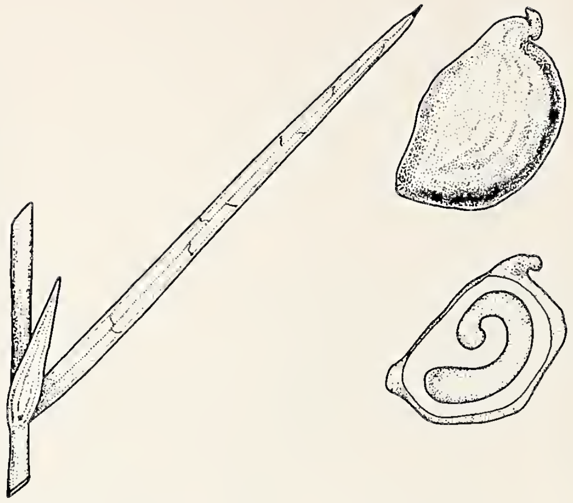
SLENDER MARSH BLUEGRASS (Grass Family, Poaceae)

Poa paludigena Fern. & Wieg.

Status:	Endangered in New York State (E-1) Federally considered for listing.
Rarity:	A very rare species of the Great Lakes region, *Poa paludigena* has been reported from a number of sites in central New York, but most of its stations have been destroyed. No populations are currently known to persist, and none have been reported in the last fifty years. The plant is very rare throughout its range, and its habitat requirements are not understood. The plant apparently occurs in calcareous wetlands, but often on *Sphagnum;* it does not seem to occur in deep acidic *Sphagnum* bogs, but rather in superficial mats overlying calcareous deposits. It should be actively sought.
Habitats:	Open fens and bogs, often marly or calcareous areas; associated with peat moss at hummock borders.
D.E.C. Regions:	2, 6, 7, 8
Counties:	Bronx, Chemung, Lewis, Monroe, Wayne, Tompkins

Like other Bluegrasses, this species is marked by leaves with boat-shaped tips. It is a very slender, weak-stemmed plant with an open, sparsely-flowered inflorescence. In New York, it is most likely to be confused with *P. sylvestris. Poa paludigena* is more slender, with narrower leaves and a smaller, more open inflorescence with, at most, three basal branches rather than four or more that are characteristic of *P. sylvestris*.



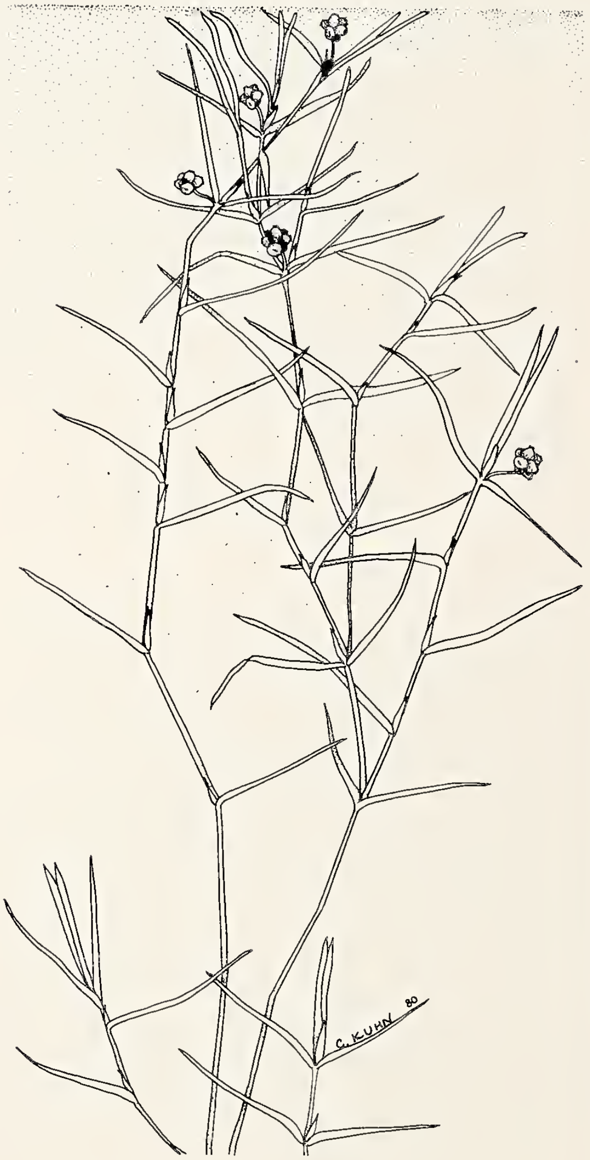


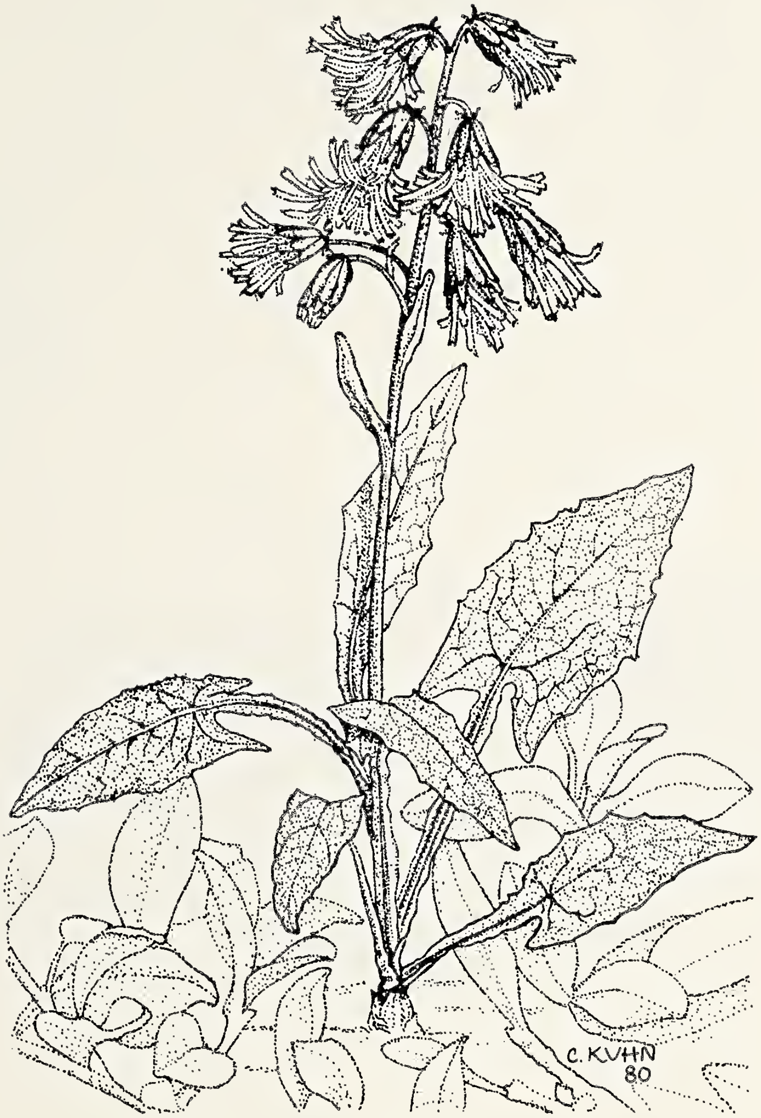
HILL'S PONDWEED (Pondweed Family, Potamogetonaceae)

Potamogeton hillii Morong

Status:	Endangered in New York State (E-1) Federally considered for listing.
Rarity:	These plants are found in situations where aquatic succession is taking place, and they do not appear to persist for long periods of time. This adds to the difficulty in determining overall rarity, since a number of historical sites are no longer intact, and several ponds no longer exist. The species is reported from Canada, Connecticut, Massachusetts, Missouri, New York, Ohio, Pennsylvania and Vermont. In New York State it has been reported at eight sites, of which it is known to survive at two.
Habitats:	Lakeshores, beaver ponds and artificial impoundments, submerged in 1–4 ft. of water. Associated with high carbonates.
D.E.C. Regions:	4, 5, 7
Counties:	Columbia, Dutchess, Tompkins, Washington

These slender Pondweeds are easily confused with other narrow-leaved species, but they may be distinguished by a combination of leaf characters. A leaf has three major veins and a slender, short bristle at the tip.





BOOTT'S RATTLESNAKE-ROOT (Aster Family, Asteraceae)

Prenanthes boottii DC.

Status: Endangered in New York State (E-1) Federally considered for listing.

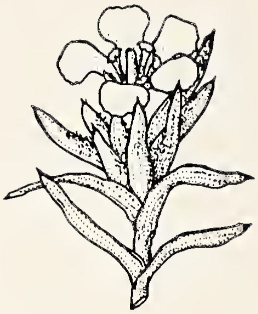
Rarity: Found on alpine summits in Maine, New Hampshire, New York and Vermont. Very rare in New York State, being known only from two frequently-visited Adirondack peaks and extirpated from another.

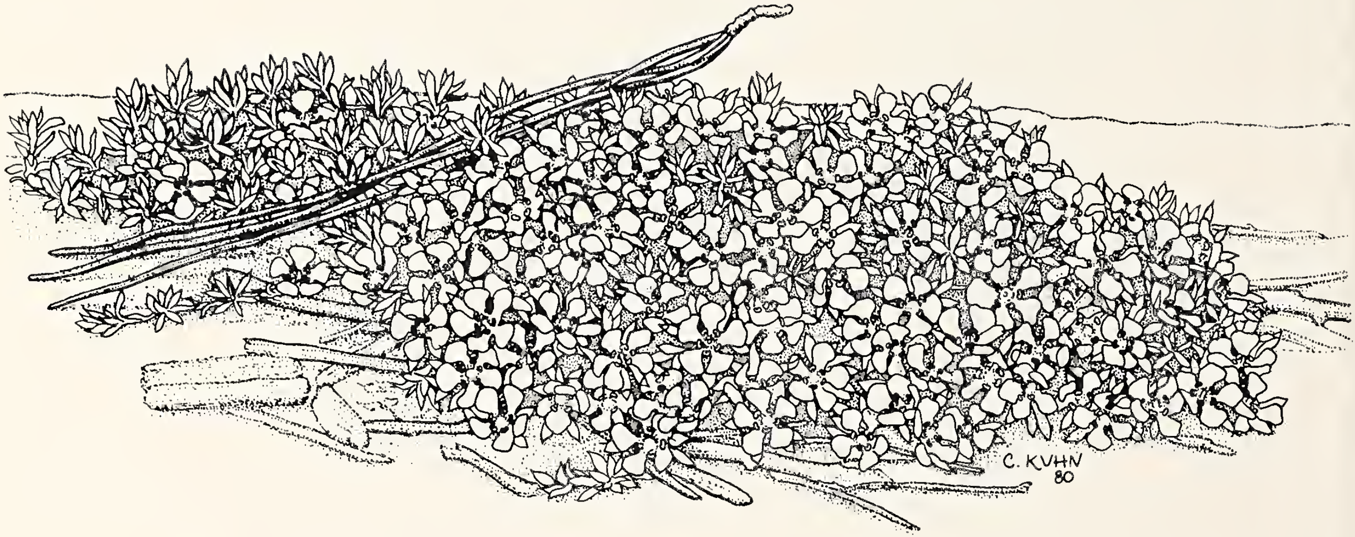
Habitats: Grassy meadows and soil between boulders and talus of alpine summits and slopes.

D.E.C. Region: 5

County: Essex

These small plants may grow mixed with other *Prenanthes* species; they are distinguished by their whitish flowers, compared with yellow or dark cream in other Rattlesnake-roots. The leaves may have their bases sharply to bluntly lobed (not flared or ear-like), or one or both of the lobes may frequently be lacking.





PYXIES "FLOWERING MOSS" (Diapensia Family, Diapensiaceae)
Pyxidanthera barbulata Michx.

Status: Endangered in New York State (E-2)

Rarity: A single station is known from New York State at the northern limits of the range of this Coastal Plain species. The plants are found in some abundance in the New Jersey Pine Barrens, scattered southward in sandy, coastal areas to Virginia. The Sandhills variety from inland in the Carolinas (var. *brevifolia*) is under review for Federal protection.

Habitats: Dry pine and oak woodland on shallow organic deposits over sand (often in burned-over areas)

D.E.C. Region: 1

County: Suffolk

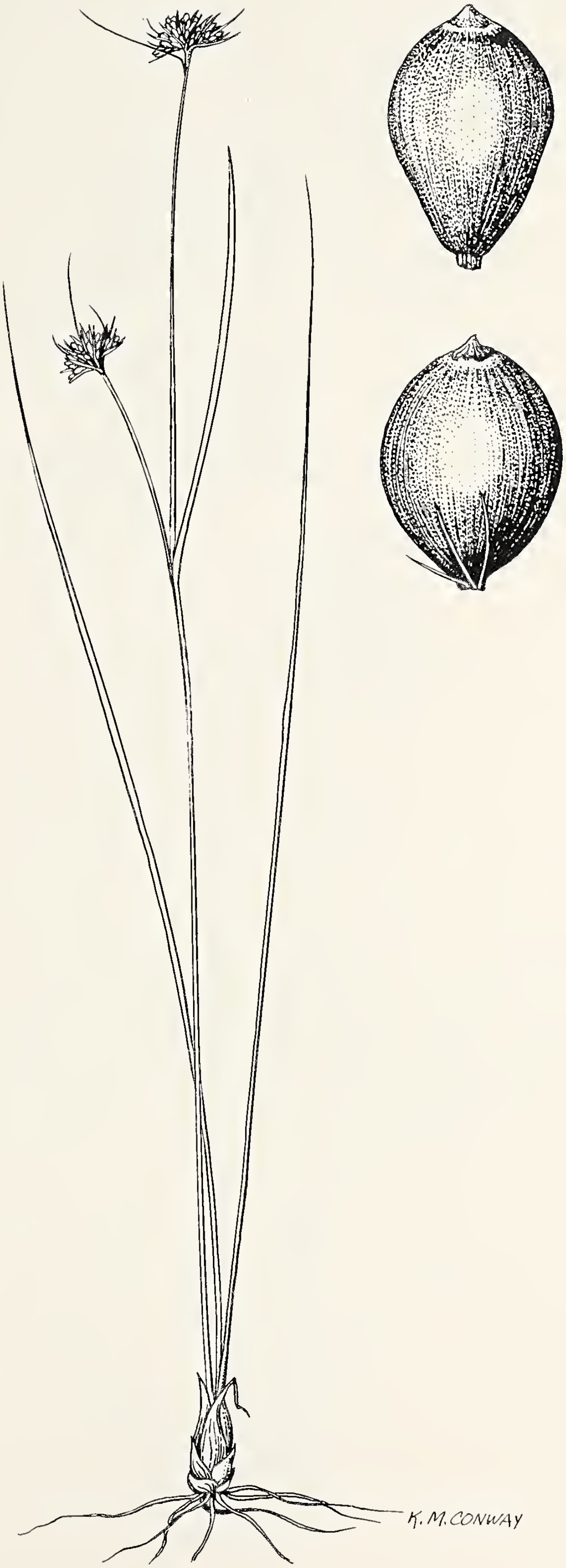
These are some of the tiniest of flowering plants. They resemble mosses and are sometimes called "Flowering Moss." The minute stems and leaves spread in fine mats on the ground. The plants are covered with white to pinkish, 5-parted flowers in early spring.

PALE BEAKRUSH (Sedge Family, Cyperaceae)

Rhynchospora pallida Curtis

Status:	Endangered in New York State (E-2)
Rarity:	This rare sedge species is at its northern limits at the only known New York State location in central Long Island. It ranges to North Carolina, and is listed in the endangered plant lists of Delaware, Maryland and Virginia, apparently being very local throughout its range.
Habitats:	Wet depressions and boggy places in pinelands; cedar swamps
D.E.C. Region:	1
County:	Suffolk

Pale Beakrush bears it flowers in dense clusters at the stem tips. It has bulbous bases, unlike many other species. It differs from similar looking Beakrushes (*R. fusca* and *R. filiformis*) in having 1–3 very short bristles (or none) at the base of each seed-like fruit (rather than 6 longer ones). It is distinguished from *R. grayi* by its smooth fruits.

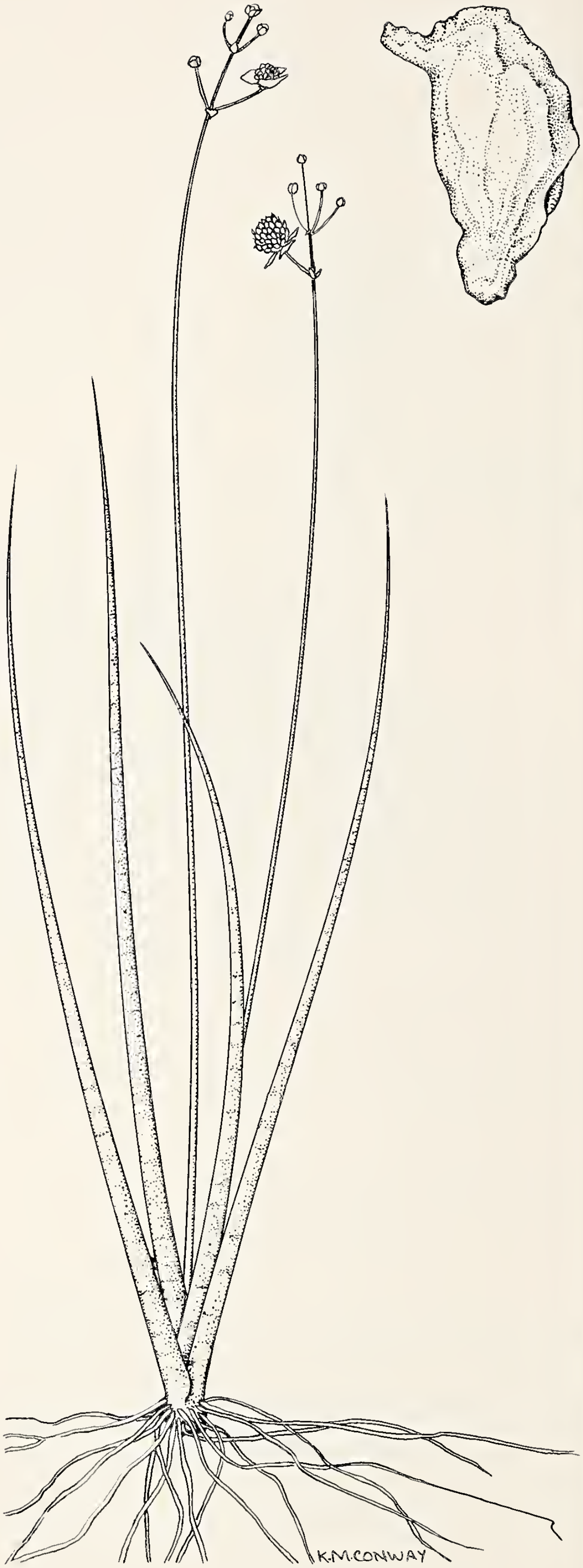


QUILL-LEAVED ARROWHEAD (Waterplantain Family, Alismaceae)

Sagittaria teres Wats.

Status:	Threatened in New York State (T-2)
Rarity:	This species has a spotty distribution, occurring primarily on Cape Cod. It is scattered sparsely from Long Island, New York, down the Atlantic coast to eastern Maryland. It is rare and vulnerable, reported as a declining wetland species in the endangered plant lists of Maryland, Delaware and Massachusetts.
Habitats:	Moist, sandy shores and swamp borders
D.E.C. Region:	1
County:	Suffolk

This species may be told from similar ones (like *S. graminea*) by its quill-like leaves (phyllodes) which are circular in cross section rather than flattened. The leaves are usually also segmented and are from 6 inches to 2 feet tall. Flowers are white and the fruits are borne in dense, bur-like heads.

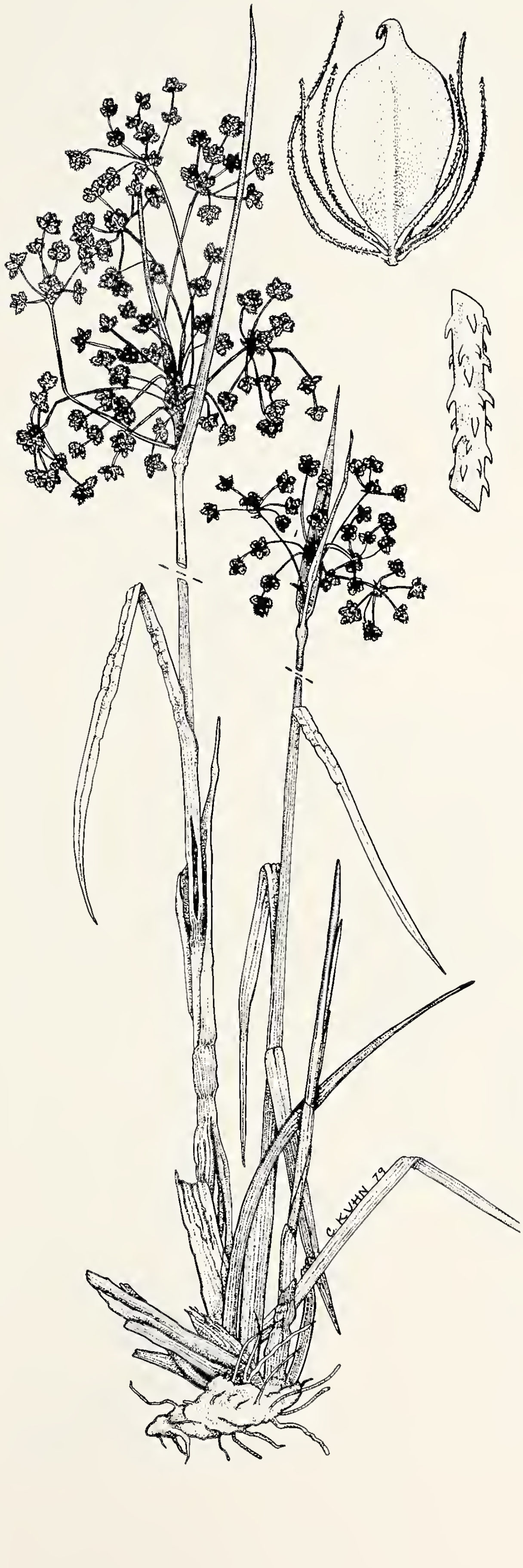


NORTHERN BULRUSH (Sedge Family, Cyperaceae)

Scirpus ancistrochaetus Schuyler

Status:	Possibly extirpated from New York State (X-1); Federally considered for listing.
Rarity:	This is a sporadically distributed entity, known from a few sites in Massachusetts, New York, Pennsylvania, Vermont and Virginia. Since it may easily be mistaken for more common Bulrushes, it may be widely overlooked.
Habitats:	Marshy places, sedge-meadows and fens
D.E.C. Region:	5
County:	Washington

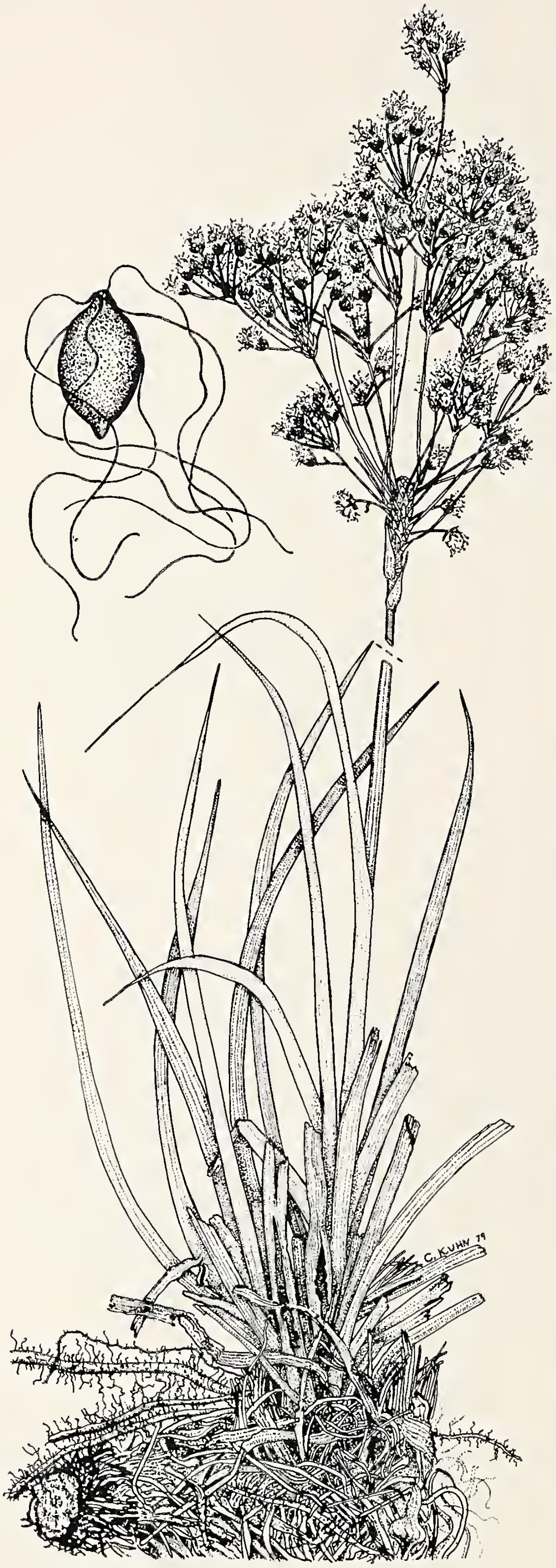
These plants are very difficult to distinguish from a common Bulrush *(S. atrovirens)*, the most reliable character being microscopic. Around the seed-like fruits are bristles which have tiny, backward-directed barbs which are thick at the base (Fig. 48) and resemble the fangs of a snake. Such barbs in *S. atrovirens* are slender. The single New York State specimen was collected at "Mt. Nebo, 1,800 ft.," a location that many old maps and the aid of the Washington County Historical Society have not enabled us to find. This perplexing specimen also has a packet containing three types of fruits: 1) those corresponding with *S. ancistrochaetus* 2) those like *S. atrovirens* and 3) intermediates, suggesting possible hybridization at the site if several plants were sampled.



LONG'S BULRUSH (Sedge Family, Cyperaceae)
Scirpus longii Fern.

Status:	Probably extirpated in New York State (X-1); Federally considered for listing.
Rarity:	This species was formerly known from six stations in Massachusetts, one in Connecticut and one in New York, but is probably extirpated in all these. The plants are still known from New Jersey.
Habitat:	Meadows and marshes.
D.E.C. Region:	2
County:	Queens

This species of sedge grows 2–5 ft. tall with tough, underground stems (rhizomes) and leaves which are strap-shaped and borne in clumps. It flowers seldom and is less likely to be collected that its common relatives. When it flowers, a plant will produce a tall stalk topped by a branched cluster of woolly spikelets. Its nearest relative is *Scirpus atrocinctus*, from which it may be distinguished by the glutinous base of its main flower cluster and by its fruits which are chestnut-brown when ripe rather than pale.

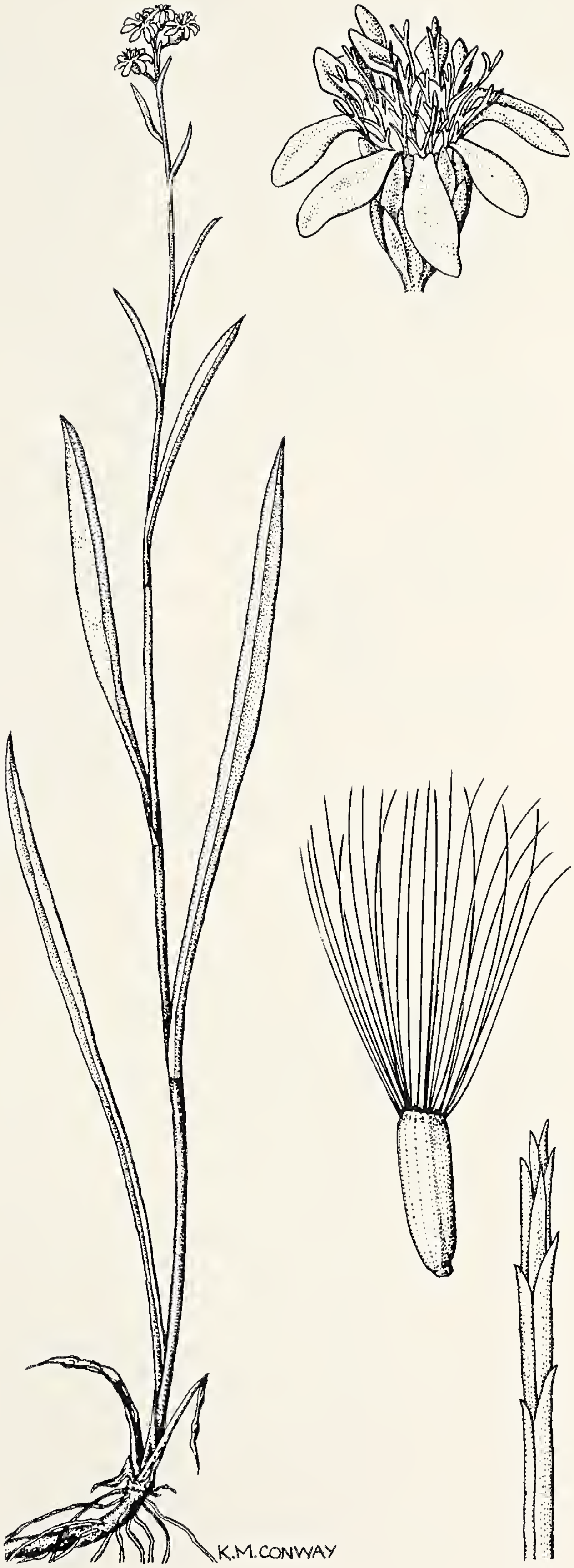


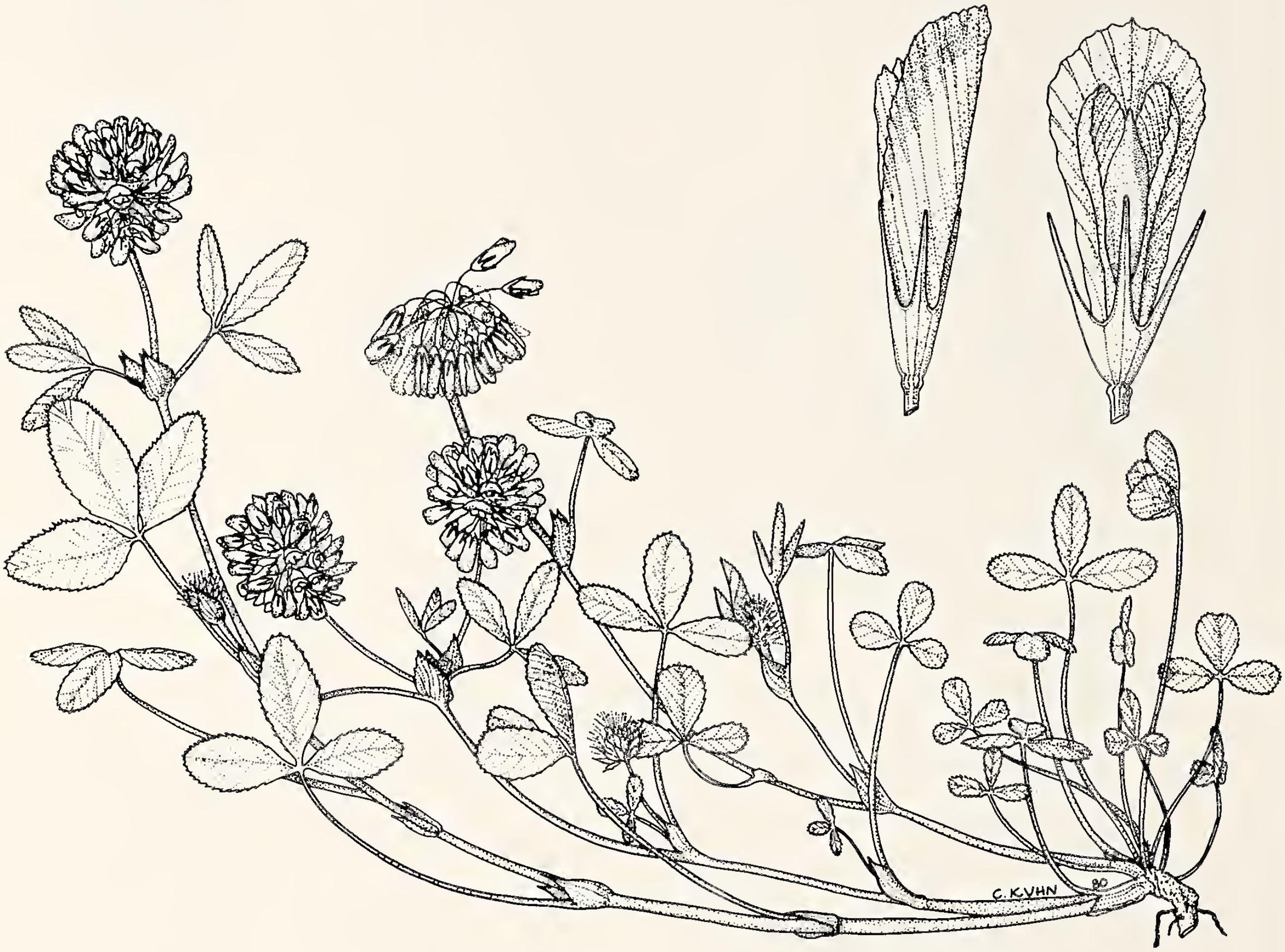
HOUGHTON'S GOLDENROD Aster Family, Asteraceae)

Solidago houghtonii T. & G.

Status:	Threatened in New York State (T-1) Federally considered for listing.
Rarity:	A rare and very restricted plant of the shores of northernmost Lakes Michigan and Huron, this species is disjunct at a single station in western New York. The New York population is protected by the ownership of a private conservation organization, but is threatened by invasion of Common Reed, *Phragmites communis.*
Habitat:	This species occurs in open sand and on limestone outcroppings in the principal portion of its range; in New York it occurs in marly fen meadows.
D.E.C. Regions:	8
Counties:	Genesee

The genus *Solidago* is large and complex, and identification of plants can be difficult. Houghton's Goldenrod is unusual, however, and can be distinguished by its dense, somewhat flat-topped cluster of 5–15 rather large flower-heads and narrow (generally less than ½ inch wide) leaves which lack small glandular spots. *Solidago houghtonii* has been reported to have arisen through hybridization of *S. ohiensis* and *S. ptarmicoides*, and can be confused with occasional hybrids of these species. The New York plants have been referred to such hybrids in the literature, but our recent chromosome studies indicate that New York plants are the polyploid *S. houghtonii* or a separately derived endemic species.





BUFFALO CLOVER (Bean Family, Fabaceae)

Trifolium reflexum L. var. *glabrum* Lojac

Status: Probably extirpated from New York State (X-2)

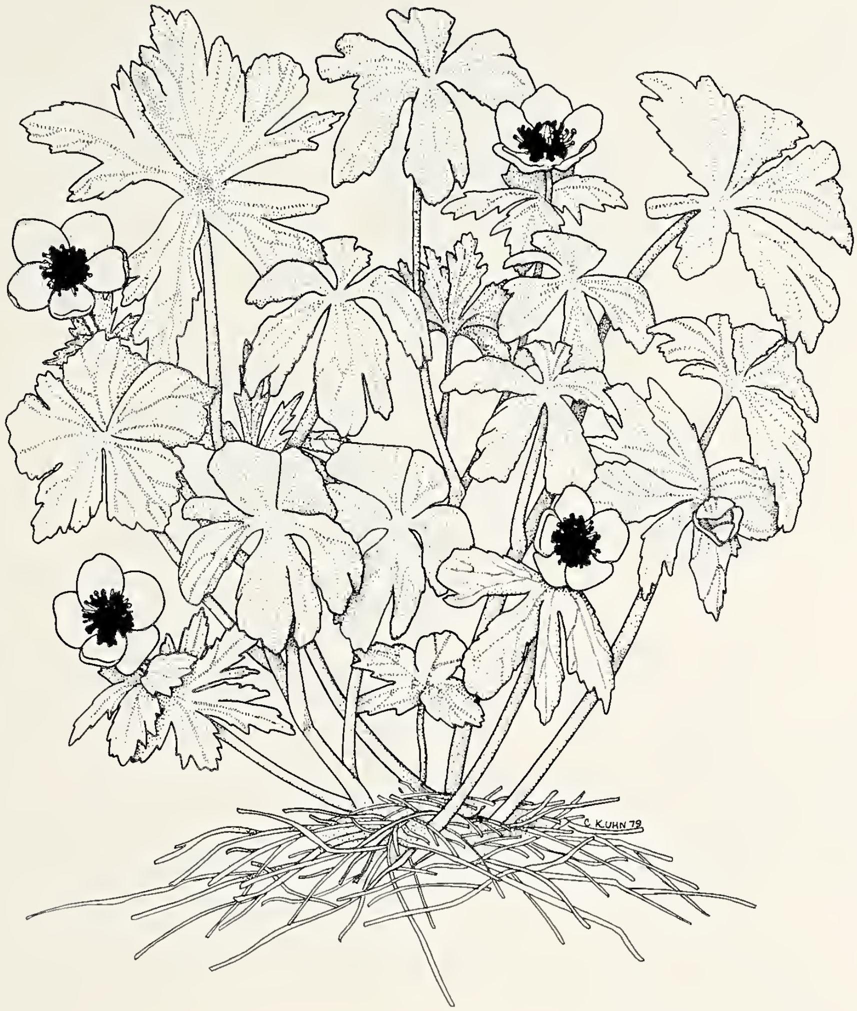
Rarity: A rare, midwestern plant found eastward very rarely in the Great Lakes region. *Trifolium reflexum* occurs primarily in the southeast and midwest; the midwestern and more northern populations represent var. *glabrum*. The species has disappeared throughout much of its range, and has not been correctly reported from New York State in this century. It is an annual or biennial which appears to be very susceptible to extirpation; it very likely has been lost from New York's flora.

Habitat: Prairies, barrens, open woods, and clearings.

D.E.C. Regions: 6, 7, 8

Counties: Broome, Monroe, Oneida, Onondaga, Wayne.

Buffalo Clover is a showy species with large heads of red and white or pinkish flowers. The individual flowers have very long calyx lobes (free segments 2–4 times as long as the fused basal portions) and are borne on long pedicels (up to ½ inch long), resulting in a large, loose head of flowers. These two characteristics distinguish it from the common Alsike Clover (*T. hybridum*).



GLOBEFLOWER (Crowfoot Family Ranunculaceae)
Trollius laxus Salisb. ssp. *laxus*

Status: Threatened in New York State (T-1) Federally considered for listing.

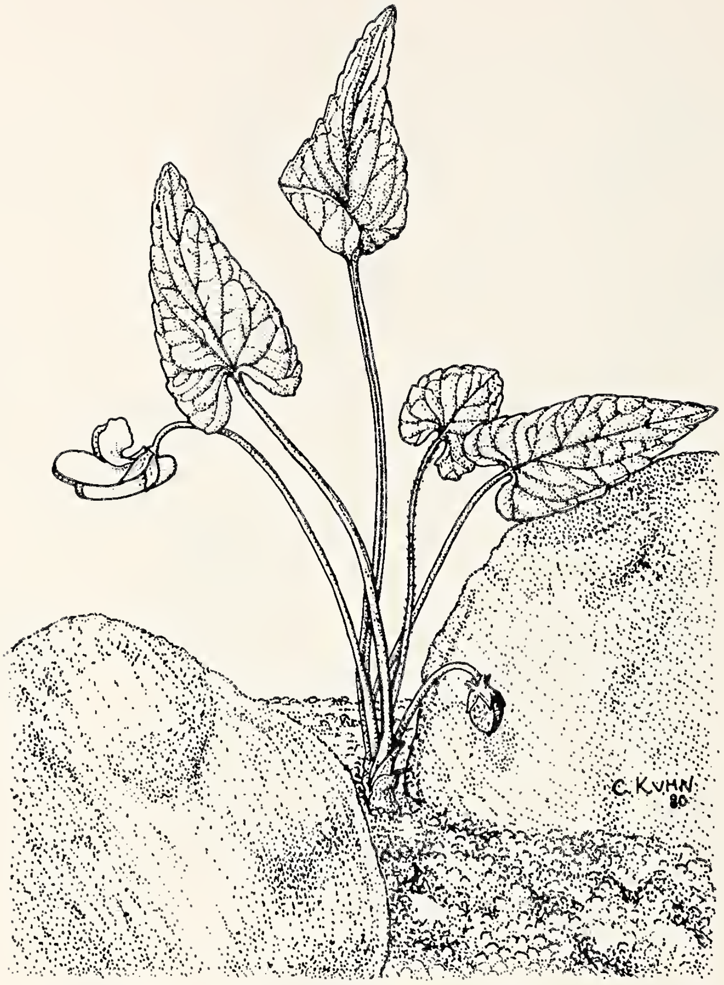
Rarity: The typical subspecies of Globeflower is a rare native of the eastern United States, known from Connecticut, New Jersey, New York, Pennsylvania and Ohio. Subspecies *albiflora* has white to cream, rather than yellow flowers, is less rare, and ranges from the Rocky Mountains to the west coast. New York State has the greatest number of populations and individuals of the eastern subspecies, but it is still a rarity, being mostly extirpated in the southern counties.

Habitats: Marly swales and hummocky meadows on wet ground, to swamp forests in which they are apparently eventually shaded out. Plants grow in transition zones between forest and wet clearings where grazing animals are often a problem.

D.E.C. Regions: 3, 4, 6, 7, 8, 9

Counties: Bronx, Cayuga, Chautauqua, Erie, Genesee, Herkimer, Livingston, Madison, Monroe, Oneida, Onondaga, Ontario, Orange, Otsego, Rockland, Schenectady, Schuyler, Sullivan, Tompkins, Ulster, Westchester, Wyoming.

The Globeflower of the eastern United States is a showy plant with yellow to bright cream-colored flowers about an inch in diameter, much like those of a Buttercup (*Ranunculus*). Flowers differ from Buttercups in having an extra series of blunt, sterile lobes with the stamens (Fig. 52). The leaves are variable and palmately cut and lobed. The plants are vulnerable to wildflower gardeners and grow in habitats particularly subject to natural and man-made change.



NEW ENGLAND VIOLET (Violet Family, Violaceae)
Viola novae-angliae House

Status:	Endangered in New York State (E-1) Federally considered for listing.
Rarity:	*Viola novae-angliae* is a rare species throughout most of its range, from New England to the Great Lakes region; it is known from Maine, Michigan, Minnesota, New York and Wisconsin; it is a sporadically distributed species, being relatively common only in the western Lake Superior region.
Habitat:	It occurs in sandy and gravelly pockets among cobbles and other rocks along water courses. It seems to require open situations, and since streambanks and shores of its region are generally thicketed and forested, habitat is rare. The area where it grows in New York State has been devastated year after year by ice-rafting. By 1980 the known New York population was three plants, but about two dozen more were found in 1981.
D.E.C. Region:	5
County:	Warren

Viola novae-angliae is one of the blue-purple flowered species with unlobed leaves. Within this group of species, it is distinct in its relatively long, rather triangular leaves which are at least as long as broad, and often longer. When flattened, the leaves of the other species tend to be broader than long.

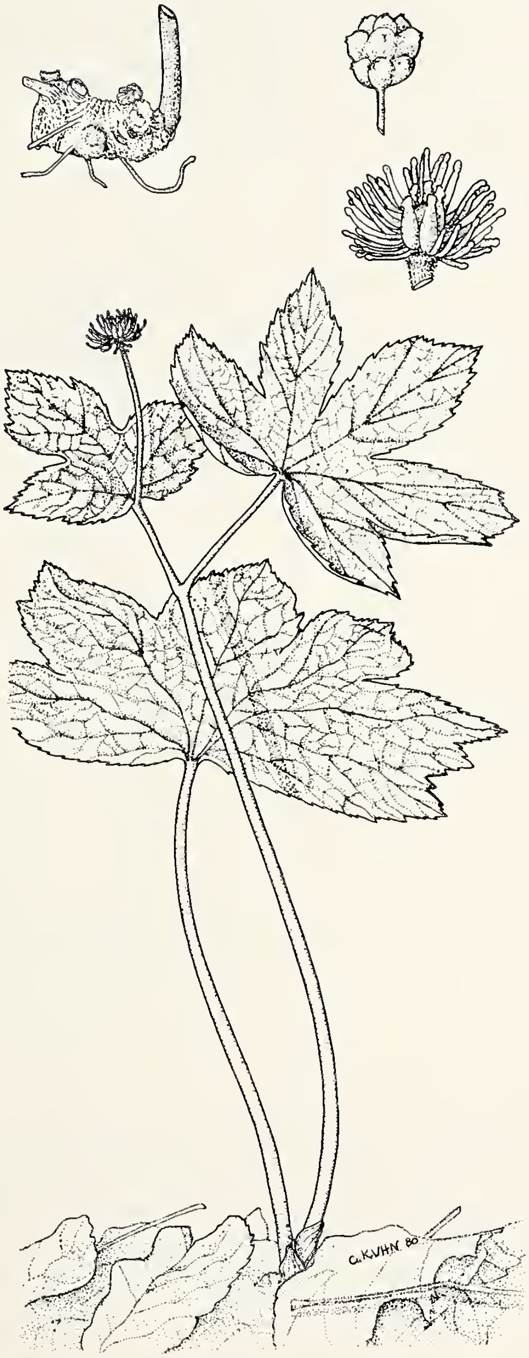
Widespread Plants Threatened by Commercial Demand

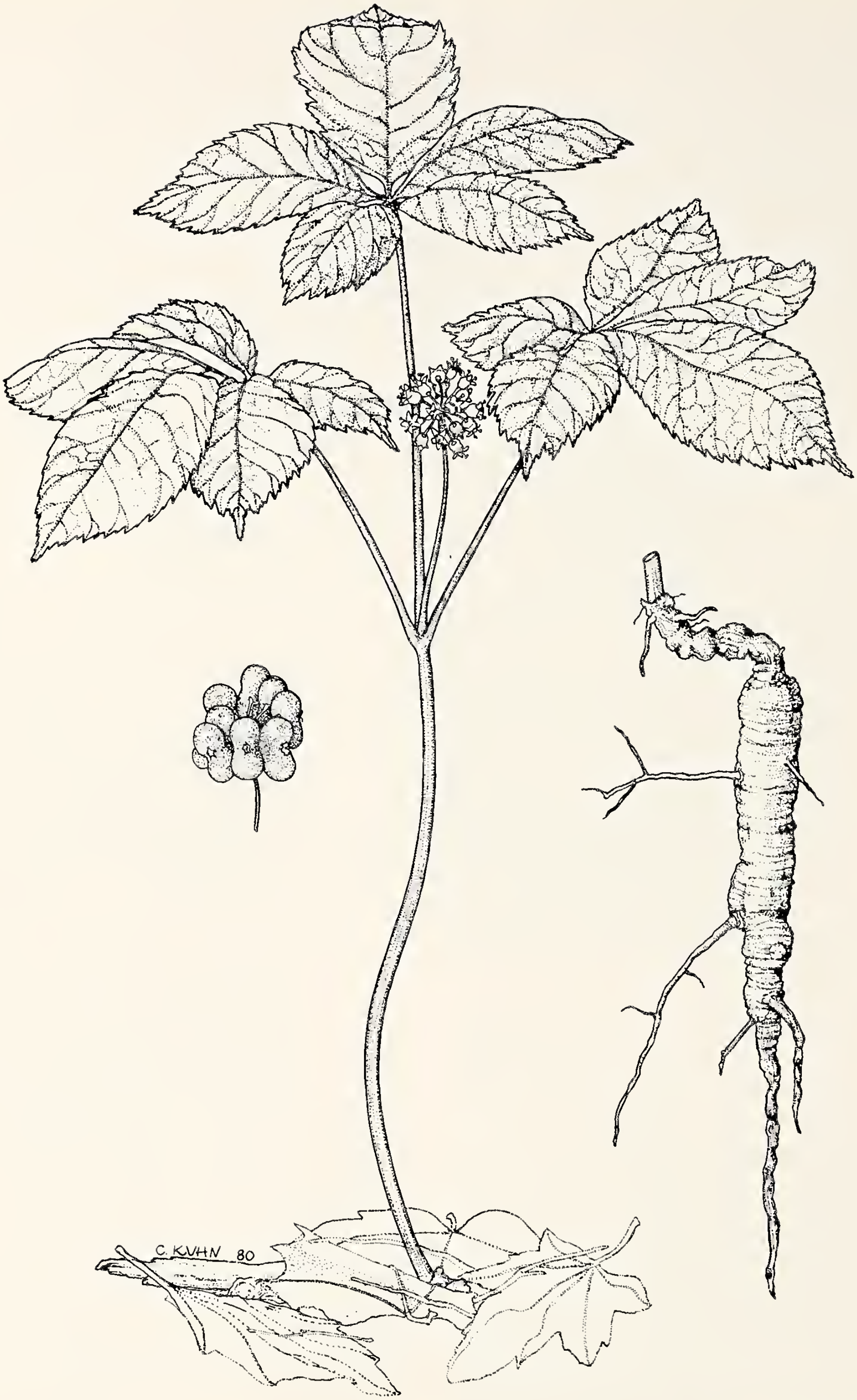
There has long been a market for natural herbs and remedies, but most intensive gathering in the past was for export purposes, especially to the Orient. With increased popularity in the United States and Canada of "back-to-nature" books, modern herbals and cookbooks, collecting pressure on native plants has grown. Two herbs of the eastern American forests have been sought out more intensively than others, due to the price they will bring: Ginseng (*Panax*) and Golden-seal (*Hydrastis*). Ginseng was once a common plant, but Golden-seal has never been very frequent, especially in the northern part of its range. Management of these species is being considered by most states in which they occur, and programs have been initiated by some state conservation agencies. The Department of Environmental Conservation of New York State has Ginseng management responsibility, and should be consulted on matters pertaining to that species.

GOLDEN-SEAL, YELLOW PUCCOON (Crowfoot Family, Ranunculaceae)
Hydrastis canadensis L.

Status:	Commercially exploited; protected in New York State (C-1)
Rarity:	Known in 23 states and Canada in eastern North America, but uncommon in New York State with sites mostly confined to the central and western counties.
Habitats:	Rich soil and humus, often on forest floors near the bases of limestone cliffs and slopes
D.E.C. Regions:	3, 4, 5, 6, 7, 8, 9
Counties:	Cayuga, Columbia, Erie, Genesee, Madison, Monroe, Niagara, Oneida, Onondaga, Orange, Rensselaer, Saratoga, Schuyler, Seneca, Tompkins, Wayne, Yates

These plants are quite distinctive, bearing only two or three broad, toothed leaves (Fig. 54). The single flower is not conspicuous, and derives its color primarily from numerous, white stamens. The fruits are red berries, borne in a dense head. The root is knotty, tuberous and yellowish, and is the part collected for use as an herb. Extracts of the roots are used in preparations for membrane inflammations, intenstinal disorders and sore eyes. Roots contain Berberine and are known to be astringent, laxative and anti-bacterial in action.





AMERICAN GINSENG *Panax quinquefolius*. The popularity of this herb in folk medicine, first in the Orient and more recently in the western world, has led to its serious depletion. Though it may be grown commercially, the wild-grown roots are distinguishable and draw a much higher price from Ginseng and fur dealers. Regulation by federal and state agencies will no doubt take many forms in the future with increasing export restrictions and population monitoring.

GINSENG (Aralia Family, Araliaceae)

Panax quinquefolius L.

Status: Export regulated under terms of the Convention on International Trade in Rare and Endangered Species of Wild Flora and Fauna; commercially exploited; protected in New York State (C-3)

Rarity: Widespread in the deciduous forests of the eastern and midwestern United States and adjacent Canada. Seriously depleted due to commercial collection for drug use.

Habitat: Rich, deciduous forests

D.E.C. Regions: All

Counties: Albany, Broome, Cattaraugus, Cayuga, Chautauqua, Chemung, Columbia, Cortland, Erie, Essex, Delaware, Dutchess, Genesee, Greene, Hamilton, Herkimer, Jefferson, Livingston, Madison, Monroe, Montgomery, Niagara, Oneida, Onondaga, Ontario, Orange, Orleans, Oswego, Rensselaer, Rockland, Saratoga, Schenectady, Seneca, Steuben, Suffolk, Sullivan, Tioga, Tompkins, Ulster, Warren Washington, Wayne, Westchester, Wyoming, Yates.

Ginseng is not readily confused with other plants in our area. Its close relative, Dwarf Ginseng, is a much smaller plant with leaves composed of three leaflets rather than five as in Ginseng. Occasionally, Wild Sarsaparilla (*Aralia nudicaulis*) is confused with it, but this plant does not have the whorl of terminal leaves surrounding the flower cluster as Ginseng does; rather, the leaf and flowers are borne on different stalks arising separately from the ground. Ginseng was originally a common and widespread plant in much of the forested region of the eastern United States and Canada. It was early recognized as a suitable substitute for Chinese Ginseng (*P. pseudoginseng*), known as a panacea in oriental folk medicine. Its medical and mystical properties have placed it in such high demand that widespread and intensive collection for export has seriously depleted populations throughout its range. Commercial collectors and others interested in the plant often ascribe very strict habitat requirements to the species. It is frequently said to require particular slopes, moisture regimes, and certain species of hardwood cover. In fact, these preferences seem more to reflect past collecting pressures and land-use patterns, for the species occurs in a great variety of forest types and even colonizes old farmland and roadsides. It seems primarily to require moderate shade and a moist, rich soil that is not too acidic. This latitude of tolerance is reflected in the wide range of the species.

Rare Plant Species Recommended for High Priority Protection in New York State

The following species are considered by the authors to be qualified for protection in New York on the basis of overall rarity and/or vulnerability to commercial exploitation. High on this priority list are species studied federally and found to be in need of protection. Certain species not listed federally, however, are very rare in New York State and elsewhere, and these are also included here for State protection. A number of widely know rarities of the northeastern United States will not be found listed here, since they are relatively common elsewhere in North America, Europe or Asia. In a few cases commercial demand and collecting pressure were taken into consideration when listing a species.

1. *Botrychium minganense* Victorin
MINGAN MOONWORT
Family: Ophioglossaceae (Adder's-tongue Family)
Status: New York State E-2

2. *Botrychium ternatum* (Thunb.) Sw.
TERNATE GRAPE FERN
Family: Ophioglossaceae (Adder's-tongue Family)
Status: New York State T-2

3. *Lygodium palmatum* (Bernh.) Sw.
CLIMBING FERN
Family: Schizaeaceae (Curlygrass Family)
Status: New York State E-2 (also commercially exploited)

4. *Schizaea pusilla* Pursh
CURLYGRASS
Family: Schizaeaceae (Curlygrass Family)
Status: New York State E-1 (Federally considered for listing)

5. *Phyllitis scolopendrium* (L.) Newm.
HART'S-TONGUE
Family: Polypodiaceae (Polypody Family)
Status: New York State E-1 (Federally considered for listing)

6. *Woodsia oregana* D.C. Eaton var. *cathcartiana* (Rob.) Mort.
CATHCART'S WOODSIA, "OREGON WOODSIA"
Family: Polypodiaeae (Polypody Family)
Status: New York State E-1 (Federally considered for listing)

7. *Potamogeton hillii* Morong
HILL'S PONDWEED
Family: Potamogetonaceae (Pondweed Family)
Status: New York State E-1 (Federally considered for listing)

8. *Sagittaria teres* Wats.
QUILL-LEAVED ARROWHEAD
Family: Alismaceae (Water Plantain Family)
Status: New York State T-2

9. *Muhlenbergia torreyana* (Schultes) Hitchc.
TORREY'S MUHLY
Family: Poaceae (Grass Family)
Status: New York State E-2 (Federally considered for listing)

10. *Poa paludigena* Fern. & Wieg.
SLENDER MARSH BLUEGRASS
Family: Poaceae (Grass Family)
Status: New York State E-1 (Federally considered for listing)

11. *Rhynchospora pallida* Curtis
PALE BEAKRUSH
Family: Cyperaceae (Sedge Family)
Status: New York State E-2

12. *Corallorhiza striata* Lindl.
STRIPED CORALROOT
Family: Orchidaceae (Orchid Family)
Status: New York State E-2

13. *Cypripedium arietinum* R. Br.
RAM'S-HEAD LADYSLIPPER
Family: Orchidaceae (Orchid Family)
Status: New York State T-1 (Federally considered but not listed)

14. *Cypripedium candidum* Muhl. ex Willd.
SMALL WHITE LADYSLIPPER
Family: Orchidaceae (Orchid Family)
Status: New York State E-1 (Federally considered but not listed)

15. *Platanthera leucophaea* (Nutt.) Lindl.
PRAIRIE WHITE-FRINGED ORCHID
Family: Orchidaceae (Orchid Family)
Status: New York State E-1 (Federally considered for listing)

16. *Isotria medeoloides* (Pursh) Raf.
SMALL WHORLED POGONIA
Family: Orchidaeeae (Orchid Family)
Status: Federally proposed as Endangered; New York State E-1

17. *Listera auriculata* Wieg.
AURICLED TWAYBLADE
Family: Orchidaceae (Orchid Family)
Status: New York State E-1 (Federally considered for listing)

18. *Aconitum noveboracense* A. Gray
NORTHERN MONK'S-HOOD
Family: Ranunculaceae (Crowfoot Family)
Status: Federally listed Threatened; New York State T-1

19. *Hydrastis canadensis* L. GOLDEN-SEAL, ORANGE-ROOT, YELLOW PUCCOON
Family: Ranunculaceae (Crowfoot Family)
Status: New York State C-1 (rare and commercially vulnerable)

20. *Trollius laxus* Salisb. ssp. *laxus*
GLOBEFLOWER
Family: Ranunculaceae (Crowfoot Family)
Status: New York State T-1 (Federally considered for listing)

21. *Cardamine longii* Fern.
LONG'S BITTERCRESS
Family: Brassicaceae (Mustard Family)
Status: New York State T-1 (Federally considered for listing)

22. *Helianthemum dumosum* (Bickn.) Fern.
BUSHY ROCKROSE
Family: Cistaceae (Rockrose Family)
Status: New York State E-1 (Federally considered for listing)

23. *Viola novae-angliae* House
NEW ENGLAND VIOLET
Family: Violaceae (Violet Family)
Status: New York State E-1 (Federally considered for listing)

24. *Pyxidanthera barbulata* Michx.
PYXIES, "FLOWERING MOSS"
Family: Diapensiaceae (Diapensia Family)
Status: New York State E-2

25. *Hottonia inflata* Ell.
FEATHERFOIL
Family: Primulaceae (Primrose Family)
Status: New York State T-2

26. *Micranthemum micranthemoides* (Nutt.) Wettst.
MICRANTHEMUM
Family: Scrophulariaceae (Figwort Family)
Status: New York State E-1 (possibly extinct; Federally considered for listing)

27. *Plantago cordata* Lam.
HEARTLEAF PLANTAIN
Family: Plantaginaceae (Plantain Family)
Status: New York State T-1 (Federally considered for listing)

28. *Prenanthes boottii* DC.
BOOTT'S RATTLESNAKE-ROOT
Family: Asteraceae (Aster Family)
Status: New York State E-1 (Federally considered for listing)

29. *Solidago houghtonii* T. & G.
HOUGHTON'S GOLDENROD
Family: Asteraceae (Aster Family)
Status: New York State T-1 (Federally considered for listing)

Species Formerly Known From New York State

Once a species has been reported from the State and verified by a specimen, photo or site visit, it then becomes unwise to delete it from the flora, even if known populations have been extirpated. Almost any species discussed below could turn up in the State during our next field season, and these species should be protected if they do. Of the following species, however, most were known from single populations outside their continuous distribution ranges. Others have simply not been found for so long that their reappearance seems unlikely. Past occurrences based on heresay or reported in journals without citation of a voucher specimen are recorded in our files, but not reported here.

Appendix I. Species Probably Extirpated from New York State

Species	Status	Comments
Cheilanthes lanosa (Michx.) Eat. Woolly Lip-fern	X-3	Last seen (NY) 1888
Pinus echinata Mill. Shortleaf Pine	X-3	Native plants not distinguished from planted ones in its highly urbanized range in NY
Pinus virginiana Mill. Virginia Pine	X-3	Former habitat highly urban, as above
Potamogeton lateralis Morong Pondweed	X-2	Known from Hemlock Lake, 1883, only (in NY)
Deschampsia atropurpurea (Wahl.) Sheele Mountain Hairgrass	X-3	Last seen in NY on Whiteface Mountain, 1851
Carex capillaris L. Hair-like Sedge	X-3	Last seen (NY) 1894, present site of Cortland waterworks
Carex polymorpha Muhl. Sedge	X-2	Vulnerable, sporadic rarity, last seen (NY) Oakdale, 1929
Cyperus plukenetii Fern. Rough Cyperus	X-3	Last seen (NY) 1868, Staten Island
Eleocharis tortilis (Link) Schult. Twisted Spikerush	X-3	Last seen (NY) 1903, Long Island
Eleocharis wolfii A. Gray Wolf's Spikerush	X-2	A prairie disjunct on Long Island. Only reported from Queens, 1927.
Scirpus ancistrochaetus Schuyler Northeastern Bulrush	X-1	Last seen (NY) 1900, "Mt. Nebo" Washington Co. "1,800 ft."
Scirpus longii Fern. Long's Bulrush	X-1	Only NY specimen from Aqueduct, Queens Co., 1905
Commelina erecta L. Day-Flower	X-3	Only NY collection from NYC, 1905
Amianthium muscaetoxicum (Walt.) Gray, Fly-poison	X-3	Last seen 1926; known from NY in Queens and Nassau Counties only
Narthecium americanum Ker. Yellow Asphodel	X-1	Last seen (NY) White Plains, 1880

Species	Status	Comments
Helonias bullata L. Swamp Pink	X-3	Only NY record from Staten Island, 1880's
Smilax pseudo-china L. False China-root	X-3	Last seen NYC, 1903
Amerorchis rotundifolia (Banks) Hultén Round-leaved Orchis	X-2	Very rare in U.S.; not seen (NY) since 1881
Castanea pumila (L.) Mill. Chinquapin	X-3	Last reported (NY) on Staten Island in the 1840's
Quercus phellos L. Willow Oak	X-3	Last NY report 1914; now cultivated within its old natural range
Phoradendron flavescens (Pursh) Nutt. American Mistletoe	X-3	Last reported from Staten Island in the 1880's
Anemone multifida Poir. Cut-leaved Anemone	X-3	Very rare in eastern U.S.; last seen (NY) 1840's
Isopyrum biternatum (Raf.) T.& G. False Rue Anemone	X-3	Only specimen (NY) Buffalo, 1830's
Ranunculus rhomboideus Goldie Prairie Buttercup	X-3	Known from a single NY specimen with no location data, early 1800's
Geum triflorum Pursh Prairie Smoke	X-3	Rare in eastern U.S.; last seen (NY) 1840's
Clitoria mariana L. Butterfly Pea	X-3	Last seen (NY) near Brooklyn, ca. 1840
Stylosanthes biflora (L.) B.S.P. Pencil-flower	X-3	Last seen (NY) Inwood, Long Island 1867
Trifolium reflexum L. Buffalo clover	X-2	Not reported since 1890's, declining throughout range
Hypericum kalmianum L. Kalm's St. John's-wort	X-3	Only known (NY) from Niagara Falls, 1901
Helianthemum propinquum Bickn. Hoary Frostweed	X-3	Last reported (NY) 1901, Hempstead, Long Island
Eryngium aquaticum L. Eryngo	X-3	Single (NY) 19th century Staten Island specimen
Thaspium trifoliatum (L.) Britt. Three-leaved Meadow-parsnip	X-3	Known in NY from Staten Island prior to 1879
Dodecatheon meadia L. Shooting-star	X-3	Only collection (NY) near Bath, 1888
Sabatia angularis (L.) Pursh Rose-pink	X-3	In NY, only from New Dorp (1879), Manhattan (1811)
Sabatia dodecandra (L.) B.S.P. Sea-pink	X-3	Known (in NY) only from Harlem and Iona Island, before 1886
Agalinis acuta Pennell Gerardia	X-1	Rare coastal plain species not recorded on Long Island since the 1920s
Schwalbea americana L. Chaffseed	X-2	Single (NY) specimen from Karner, 1860's
Aster shortii Lindl. Short's Aster	X-3	Last seen (NY) at Niagara Falls, 1888

Significance Symbols Used In Appendix II.

DECL = Observed to be declining in New York State
DISJ = Disjunct from a larger range
END = Highly restricted range, endemic
EXT? = Possibly extirpated in New York State
HAB = Restricted to habitats rare in the State
R = Rare throughout its range
SNYS = Single New York station
SPOR = Sporadic: scattered populations
VULN = Vulnerable to commercial or private exploitation or imminent land development
WRL, Western, eastern, northern or southern
ERL, range limits, or nearing the periphery
NRL, of their distributions
SRL

Appendix II. Plant Rarities of New York State Recommended for Protection if in Combination With Other Rarities (Most of These Occur in the State Five Times or Fewer)

Status Code	Species	Habitats	Significance	Comments
	ISOETACEAE			
T-3	*Isoetes eatonii* Dodge Eaton's Quillwort	Ponds, stream banks	R SPOR DECL	A few stations in NY, NJ, NH and MA, declining.
	LYCOPODIACEAE			
E-3	*Lycopodium carolinianum* L. Carolina Clubmoss	Bogs and wet barrens	SNYS VULN NRL SPOR	Pantropical, sporadic, nearing its n. limits in e. North America.
T-3	*Lycopodium sabinaefolium* Willd. Ground-fir	Woods, clearings	SERL	A northern plant at s.e. range limits, NY, PA.
E-3	*Lycopodium sitchense* Rupr. Sitka Clubmoss	Summits, brushy slopes	SERL VULN EXT?	Northwestern species reaching its limits.
	OPHIOGLOSSACEAE			
E-3	*Botrychium lunaria* (L.) Sw. Moonwort	Wooded slopes with limestone (in NY)	SRL DISJ SNYS SPOR VULN HAB	Circumboreal species, sporadic; one NY station verified 1981, others doubtful now, likely extirpated.
	POLYPODIACEAE			
T-3	*Asplenium montanum* Willd. Mountain Spleenwort	Rocky slopes, acidic soils	HAB NRL VULN	Reaching its northeastern limits in N.E.
T-3	*Asplenium viride* Huds. Green Spleenwort	Calcareous slopes	DISJ SNYS SRL VULN	Circumboreal-arctic species, also known from Mt. Mansfield, VT.

APPENDIX II. CONTINUED

Status Code	Species	Habitats	Significance	Comments
T-3	*Cystopteris protrusa* (Weath.) Blasd. Lowland Fragile Fern	Calcareous slopes, alluvia	NERL VULN R	Formerly listed as a variety of *C. fragilis*; southern
T-3	*Dryopteris celsa* (Palm.) Small Log Fern	Swampy places, often on rotting logs	NERL	A more southern species known from NY near Rochester.
T-3	*Pallaea glabella* Mett. Smooth Cliff-brake	Cliffs, limestone	ERL	Widespread but often local species at eastern limits in NY, VT.
E-3	*Polystichum lonchitis* (L.) Roth Northern Holly Fern	Calcareous slopes	DISJ VULN SERL SNYS	Northwestern species disjunct at s.e. limits, NY.
T-3	*Woodsia alpina* (Bolton) S.F. Gray Alpine Woodsia	Rocky places, ledges	DISJ VULN SPOR SRL	Circumboreal-arctic species reaching southern limits.
T-3	*Woodsia glabella* R. Br. Smooth Woodsia	Cliffs and ledges, often calcareous	VULN SRL	Northern species reaching s. limits.
	CUPRESSACEAE			
T-3	*Juniperus horizontalis* Moench Creeping Savin	Bogs and calcareous banks	SERL	A primarily northern species, ranging west as well.
	POTAMOGETONACEAE			
T-3	*Potamogeton vaginatus* Turcz. Pondweed	Deep waters	HAB SRL R	Circumboreal, nearing southern limits.
	ALISMACEAE			
E-3	*Echinodorus tenellus* (Mart.) Buch. var. *parvulus* (Englem.) Fassett Slender Burhead	Shores, mud	SNYS? EXT? NRL	Southern species nearing northern limits; last seen 1928 in Queens.
	POACEAE			
T-3	*Agrostis borealis* Hartm. Boreal Bentgrass	Alpine summits and slopes	SRL HAB VULN	Alpine to boreal-montane species; NY, N.E., NC, VA and western U.S.
T-3	*Bouteloua curtipendula* (Michx.) Torr. Side-oats Grama	Dry prairies, thickets	NERL DISJ	Common western and southern species at n.e. limits, NY, CT.
T-3	*Calamagrostis inexpansa* Gray Northern Reedgrass	Gravelly to peaty soil	SPOR	Mostly distributed north and west of NY State.
E-3	*Calamagrostis neglecta* (Ehrh.) Gaertn. Small, Northern Reedgrass	Shores	SERL SNYS EXT?	Circumboreal at southeastern limits, NY, NH.

APPENDIX II. CONTINUED

Status Code	Species	Habitats	Significance	Comments
T-3	*Calamagrostis porteri* Gray Porter's Reedgrass	Dry, wooded slopes	R	Relatively rare species ranging from central NY to West Virginia.
E-3	*Erianthus giganteus* (Walt.) Muhl. Giant Beardgrass	Swamps and glades	DISJ NRL EXT? SNYS	A distinctly southern, widespread species reported by Fernald, 1943 (last collection 1833 in NY); also NJ.
E-3	*Festuca brachyphylla* Schultes Short-leaved Fescue	Summits	DISJ SNYS SERL	Arctic-alpine species, also western Cordilleran, reaching s.e. range limits.
T-3	*Hierochloë alpina* (Sw.) R.&S. Alpine Holy-grass	Peaty meadows and alpine slopes	SRL VULN	Arctic, circumboreal reaching southern limits; also in NH.
E-3	*Muhlenbergia capillaris* (Lam.) Trin. Slender Muhly	Sandy clearings	NRL SNYS?	A southern species reaching its northern limit, (last seen 1915).
T-3	*Oryzopsis canadensis* (Poir.) Torr. Canada Ricegrass	Acid, peaty slopes	DISJ SRL	A northern species with disjunct populations to WV.
E-3	*Panicum anceps*. Michx. Panic Grass	Swampy woods	SNYS DISJ VULN NERL	Southern and midwestern species reaching northern limits on L.I.
T-3	*Panicum calliphyllum* Ashe Panic Grass	Woods	R	A rare species of scattered distribution, MA to MD. Sometimes called a var. of *P. bicknellii*.
T-3	*Panicum flexile* (Gatt.) Scribn. Panic Grass	Calcareous ledges, shores	HAB DECL	A calciphile with a broad range; rare in NY.
E-3	*Panicum leibergii* (Vasey) Scribn. Panic Grass	Open woods, grasslands	EXT? SNYS	Midwestern species, rare in northeast.
T-3	*Panicum lucidum* Ashe Panic Grass	Swampy woods	NRL	Southern species, spotty in northeast and midwest, reaching its limits, NY, CT.
T-3	*Panicum polyanthes* Schultes Panic Grass	Sandy, moist places	NERL	Nearing northeastern limits from south and midwest.
T-3	*Panicum scabriusculum* Ell. (including "*P. aculeatum*") Panic Grass	Swampy, sandy woods	R NRL VULN	A rare, sporadically distributed species, reaching its northern limits.
T-3	*Panicum scoparium* Lam. Panic Grass	Shores and swales	NERL	Nearing northern limits from south and midwest.
T-3	*Panicum stipitatum* Nash Panic Grass	Swamps and wet meadows	NERL EXT?	Southern and midwestern species; northern limits in N.E. (last seen NY, 1928).
T-3	*Paspalum debile* Michx. Paspalum	Sandy, open places	NERL	Southern and western element reaching northeastern limits on L.I.

APPENDIX II. CONTINUED

Status Code	Species	Habitats	Significance	Comments
E-3	*Poa cuspidata* Nutt. Bluegrass	Rocky woodland	NERL EXT?	Southern and midwestern element (last seen 1909) Staten Is. and Manhattan.
E-3	*Poa fernaldiana* Nannf. Fernald's Bluegrass	Alpine summits	SPOR SNYS SWRL	Northeastern alpine species at southern limits in N.E. and NY.
T-3	*Poa glauca* Vahl. Bluegrass	Dry, rocky, often calcareous slopes	SERL	Northwestern and Eurasian, reaching southeastern limits for U.S.
T-3	*Sporobolus clandestinus* (Biehl.) Hitchc. Rough Rushgrass	Sandy soils	NRL	Southeastern species reaching northern limits in CT, NY.
E-3	*Sporobolus heterolepis* Gray Northern Dropseed	Rich prairies and calcareous, rocky areas	DISJ VULN	A prairie species reaching its eastern limits.
T-3	*Uniola laxa* (L.) B.S.P. Slender Spikegrass	Wet woods and swamps	NERL	A southern species reaching n.e. limits.
	CYPERACEAE			
T-3	*Carex aggregata* MacKenzie Sedge	Woods, meadows, thickets	NERL	An eastern to midwestern species at n.e. limits.
T-3	*Carex arcta* Boott Sedge	Moist woods, swales	SERL	A western and northern species at s.e. limits, NY, VT.
T-3	*Carex atherodes* Spreng. Sedge	Limey meadows, swales, etc.	SERL	A circumboreal species at southeastern limits, NY, OH.
T-3	*Carex atratiformis* Britt.	Alpine summits	SRL DISJ R	Arctic-alpine species at southern limits
T-3	*Carex barrattii* Schw. & Torr. Sedge	Pinelands, swamps	NRL	A coastal plain species reaching n. limits NY, CT.
T-3	*Carex caroliniana* Schwein. Sedge	Woods, meadows	SNYS NERL	Midwestern and southern species at n.e. limits, NY.
T-3	*Carex conjuncta* Boott Sedge	Moist habitats, limestone	NERL	Midwestern and Appalachian at n.e. limits NY.
T-3	*Carex crawei* Dew. ex Torr. Craw's Sedge	Meadows, bogs limestone	ERL	Western at eastern limits; local.
T-3	*Carex emoryi* Dew. Sedge	Wetlands, limestone	NERL	Southern and western species at n.e. limits, NY, NJ.
T-3	*Carex frankii* Kunth Sedge	Meadows, limestone	NERL	Southern and midwestern at n.e. limits.
T-3	*Carex gravida* Bailey Sedge	Rich woods, wet prairies	NERL	Midwestern and Appalachian reaching n.e. limit, NY.
T-3	*Carex livida* (Wahl.) Willd. Sedge	Calcareous wetlands	SRL	European, across N.A. reaching s. limits in NY, NJ.
T-3	*Carex lupuliformis* Sartw. Sedge	Swamps, calcareous	NERL	Midwestern to southern at n.e. limits VT, NY, CT.

APPENDIX II. CONTINUED

Status Code	Species	Habitats	Significance	Comments
E-3	*Carex meadii* Dew. Sedge	Prairies	NERL SNYS	A southern and midwestern species at n.e. limits, NY.
T-3	*Carex nigra* (L.) Reich. Sedge	Cold, wet places	SWRL	Amphiatlantic at s.w. limits.
T-3	*Carex nigromarginata* Schwein. Sedge	Dry woods	NERL	Southern and midwestern at n.e. limits CT, NY.
E-3	*Carex richardsonii* R.Br. Sedge	Dry woods, prairies	SERL SYNS	Western species, reaching e. limits in OH, NY, VT.
T-3	*Carex sartwelli* Dew. Sedge	Calcareous bogs, swales	ERL	Western species reaching eastern limits, NY, PA, Quebec.
T-3	*Carex scirpoidea* Michx. Sedge	Subalpine, alpine	SRL VULN	Arctic, alpine circumboreal at s.e. limits N.E., NY.
T-3	*Carex straminea* Willd. Sedge	Marshes, swamps	NERL R SPOR	Reaching n.e. limits in MA, NY.
E-3	*Carex striatula* Michx. Sedge	Rich woods	SNYS? R SPOR	Coastal plain species rare and sporadic FL-MA, N.S.
T-3	*Carex styloflexa* Buckl. Sedge	Springs, low woods	NERL VULN	Coastal plain, mostly southern, north to NY, CT, VT.
T-3	*Carex tincta* Fern. Sedge	Fields, grassy slopes	SERL	Northern and western species at s.e. limits, NY.
T-3	*Carex vaginata* Tausch Sedge	Swamps, wet woods	SERL	Arctic-alpine, reaching s.e. limits in NY; circumboreal.
T-3	*Cyperus engelmannii* Steud. Engelmann's Cyperus	Swampy ground	NERL	Midwestern, eastern seaboard, at n.e. limits.
T-3	*Cyperus retrorsus* Chapm. Cyperus	Burns and clearings, dry sand	NRL	Coastal Plain and Piedmont species at n. limits.
T-3	*Eleocharis ambigens* Fern. Spikerush	Ponds and marshes	NRL	Coastal species nearing northern limits, NY, MA, WI.
T-3	*Eleocharis compressa* Sulliv. Flat-stemmed Spikerush	Calcareous wet places	NERL	Central U.S. species at n.e. limits.
T-3	*Eleocharis equisetoides* (Ell.) Torr. Knotted Spikerush	Shallow water	NRL SPOR	Southern species near northern limits.
T-3	*Eleocharis melanocarpa* Torr. Black-fruited Spikerush	Pinelands, shores	NERL DECL	A southeastern-midwestern species at n.e. limits NY, MA.
T-3	*Eleocharis ovata* (Roth) R. & S. Ovoid Spikerush	Moist open places	SERL	Scattered distribution north and west; s.e. range limits CT, NH, NY.
T-3	*Eleocharis quadrangulata* (Michx.) R. & S. Angled Spikerush	Pools, creeks, tidal shores	NERL	Central and southern species at n.e. limits.

APPENDIX II. CONTINUED

Status Code	Species	Habitats	Significance	Comments
T-3	*Eleocharis tricostata* Torr. Three-ribbed Spikerush	Ponds, sandy areas	R NRL	Southeastern pine-barren species reaching northern limits.
T-3	*Eleocharis tuberculosa* (Michx.) R. & S. Large-tubercled Spikerush	Shores	HAB	Coastal plain species rare in NY (L.I.)
E-3	*Eriophorum angustifolium* Roth Cotton Grass	Calcareous meadows	SRL	Arctic species, reaching southern limits.
E-3	*Fimbristylis caroliniana* (Lam.) Fern. Sedge	Sandy soils, dunes	SNYS NRL EXT?	Southern species barely reaching L.I.
T-3	*Fimbristylis castanea* (Schult.) Torr. Sedge	Sand, brackish shores	NRL	Coastal plain species at n. limits (L.I.).
E-3	*Fimbristylis drummundii* Boeckl. Sedge	Barrens, meadow, prairies	NERL SNYS EXT?	Mostly southern and western.
T-3	*Psilocarya nitens* (Vahl) Wood Bald Rush	Wet sand, coastal bogs	NRL	Southeastern and usually coastal plain n. to NY, MA.
T-3	*Psilocarya scirpoides* Torr. Bald Rush	Wet ground, pond margins	NERL	Southern and midwestern n. to NY, MA.
E-3	*Rhynchospora cephalantha* Gray Beakrush	Bogs and savannas	NRL SNYS	A coastal plain species reaching northern limits.
E-3	*Rhynchospora chalarocephala* Fern. Beakrush	Pond margins and swamps	NRL	Southeastern coastal plain species at northern limits.
E-3	*Rhynchospora globularis* Chapm. var. *recognita* Fern. & Gale Beakrush	Wet sand, clay or peat	SNYS NRL	Southern species reaching northern limits.
E-3	*Rhynchospora gracilenta* Gray Slender Beakrush	Wet sand and peat	SNYS NRL	Southeastern coastal plain element.
T-3	*Rhynchospora inundata* (Oakes) Fern. Horned Rush	Pond margins	NERL	Coastal plain element at n. limits NY, MA.
E-3	*Rhynchospora torreyana* Gray Torrey's Beakrush	Sand and peat	SNYS NRL	Southeast coastal plain species at n. limits.
T-3	*Scirpus clintonii* Gray Clinton's Clubrush	Dry to springy ledges and woods	SERL SPOR R	Spotty northern species
T-3	*Scirpus cylindricus* (Torr.) Britt. Saltmarsh Bulrush	Tidal shores, saltmarshes	SPOR R	A scattered n.e. coastal species on L.I. and in the tidal Hudson river. Often listed under S. *maritimus*.

APPENDIX II. CONTINUED

Status Code	Species	Habitats	Significance	Comments
T-3	*Scleria minor* (Britt.) Stone Nutrush	Peaty and boggy depressions	NRL	Southeastern species at northern limits.
T-3	*Scleria muhlenbergii* Steud. Nutrush	Bogs, swales, pinelands	NERL	Coastal plain to midwest, reaching n.e. limits.
T-3	*Scleria nitida* Willd. Nutrush	Dry sand	NRL	Southeastern, reaching northern limits.
T-3	*Scleria pauciflora* Muhl. var. *caroliniana* (Willd.) Wood Nutrush	Coastal pine scrub	NERL	A coastal variety of a southern-western species, reaching n. limits NH, MA, NY.
T-3	*Scleria verticillata* (Muhl.) Nees. Nutrush	Calcareous wet places	NRL	Southern; sporadic in northern range.
	ERIOCAULACEAE			
T-3	*Eriocaulon parkeri* Robins. Hatpins, Pipewort	Tidal shores	VULN R	A coastal species rare in NY (only Hudson River).
	COMMELINACEAE			
T-3	*Tradescantia virginiana* L. Spiderwort	Woods and roadsides	NRL	Eastern-central, reaching its northern limits.
	JUNCACEAE			
T-3	*Juncus brachycarpus* Engelm. Rush	Damp soil	NERL	Coastal plain and midwestern species n.e. limits MA, NY.
E-3	*Juncus coriaceous* MacKenzie Rush	Wet ground, woods	SNYS NRL EXT?	Southern species at northern limits.
E-3	*Juncus debilis* Gray Rush	Pinelands, shores	SNYS EXT?	Southeastern species at northern limits.
T-3	*Juncus diffusissimus* Buckl. Rush	Wet ground	DISJ NRL	Southern; disjunct in NY.
T-3	*Juncus platyphyllus* (Wieg.) Fern. Rush	Acid soils	NRL	Coastal plain species, rare in NY.
T-3	*Juncus stygius* L. var. *americana* Buch. Rush	Bogs and pools, limestone	SRL	Boreal species reaching southern limits.
T-3	*Juncus trifidus* L. Rush	Barrens, tundra	VULN SRL DISJ HAB	Arctic and Eurasian, reaching southern limits (with a disjunct var. in NC).

APPENDIX II. CONTINUED

Status Code	Species	Habitats	Significance	Comments
T-3	*Juncus vaseyi* Engelm. Rush	Moist thickets, shores and meadows	SERL	Reports only, but as late as 1975 (Faust and Phelps); northern and western species.
E-3	*Luzula bulbosa* (Wood) Fern. Woodrush	Open woods, clearings	NRL	Southern species approaching northern range limits.
E-3	*Luzula spicata* (L.) DC. Spiked Woodrush	Tundra	SNYS SRL	Arctic species reaching southern limits.
	LILIACEAE			
T-3	*Melanthium hybridum* Walt. Slender Bunchflower	Open woods	NERL	Appalachian and coastal plain at n. limits NY, CT.
T-3	*Melanthium virginicum* L. Bunchflower	Meadows, swales	NRL	A southern and midwestern species at northern limits.
T-3	*Smilax pulverulenta* Michx. Jacob's Ladder	Rich woods	NRL	A southern species reaching northern limits in RI.
T-3	*Tofieldia glutinosa* (Michx.) Pers. False Asphodel	Shores, marshes and wet ledges	SPOR	Ranging north and south of us but rare in NY.
T-3	*Trillium sessile* L. Toadshade	Rich woods	DISJ NERL	Southern and midwestern species, disjunct to western NY.
E-3	*Zigadenus elegans* Pursh ssp. *glaucus* (Nutt.) Hultén White Camass	Limestone and moist places	SPOR HAB	Great Lakes locally to N.E. (seen 1979 but extirpated at that location, 1980).
E-3	*Zigadenus leimanthoides* Gray False Camass	Pinelands, bogs and forest clearings	NRL	Coastal and Piedmont species at northern limits.
E-3	*Uvularia puberula* Michx. Bellwort	Woods	SNYS DISJ NRL EXT?	Southern species disjunct from WV to L.I. and NJ (*U. pudica* of manuals).
	HAEMODORACEAE			
T-3	*Lachnanthes caroliniana* (Lam.) Dandy Redroot	Meadows, wet places, bogs	DECL	Once established in several lakes and bogs (L.I.), now often overgrown; southern.
	ORCHIDACEAE			
E-3	*Calypso bulbosa* (L.) Oakes Calypso	Calcareous bogs, swamps and moist wooded slopes, conifer forests	SERL	Rare throughout the eastern portion of its range; very rare and disappearing in the northeastern U.S.
E-3	*Platanthera cristata* (Michx.) Lindl. Crested Fringed Orchid	Moist, acidic dunes and pinebarrens (NY)	NERL DISJ VULN	Highly restricted at its n.e. range limit, threatened by land development.

APPENDIX II. CONTINUED

Status Code	Species	Habitats	Significance	Comments
	SALICACEAE			
T-3	*Populus heterophylla* L. Swamp Cottonwood	Floodplains and swamps	NRL	Coastal plain species nearing northern limits on L.I., MI.
T-3	*Salix glaucophylloides* Fern. var. *albovestita* (Ball) Fern. Shoreline Willow	Great Lakes, dunes	SRL	Northern species-complex at southern limits.
E-3	*Salix herbacea* L. Dwarf Willow	Peaks	DISJ SNYS SRL VULN	Circumboreal, arctic species reaching southern limits on peaks.
E-3	*Salix pellita* Anderss. Satiny Willow	Cool banks and wetlands	SNYS SRL VULN	Northern species with southern range limits in NY and N.E.
T-3	*Salix syrticola* Fern. Sand-dune Willow	Dunes and shores	ERL DISJ	Great Lakes species (or variety of *S. cordata*); rare eastward.
T-3	*Salix uva-ursi* Pursh Alpine Willow	Peaks	VULN SRL	Arctic-alpine species reaching southern limits in NY and N.E., vulnerable, but not uncommon on high peaks.
	BETULACEAE			
T-3	*Betula glandulosa* Michx. Dwarf Birch	Peaks	SRL VULN DISJ	Alpine species reaching southern limits.
T-3	*Betula minor* (Tuckerm.) Fern. Dwarf White Birch	Peaks	SRL DISJ	Alpine species reaching southern limits.
T-3	*Betula pumila* L. Swamp Birch	Bogs, calcareous fens, etc.	HAB	Northern species, scattered in calcareous places.
	SANTALACEAE			
T-3	*Geocaulon lividum* Fern. Northern Comandra	Alpine and other montane sites	SRL DISJ	Arctic-alpine species reaching southern limits; easily overlooked.
	ARISTOLOCHIACEAE			
T-3	*Aristolochia serpentaria* L. Snakeroot	Wooded, wet places	NERL	Southern and midwestern-ozarkian species reaching n.e. limits NY, CT.
	POLYGONACEAE			
T-3	*Polygonum glaucum* Nutt. Seabeach Knotweed	Beaches	DECL VULN SPOR	Not found in several former sites; vulnerable to beach and dune disturbance.
T-3	*Rumex hastatulus* Muhl. Sorrel	Open fields, sandy sites	NRL	Southern plant reaching northern range limits.
T-3	*Rumex maritimus* L. var. *persicarioides* (L.) R. Mitchell Golden Dock	Beaches, marshes and shores	SRL VULN DECL	Plant of northern coastal marshes on the east and west coasts, reaching southern limit on L.I.

APPENDIX II. CONTINUED

Status Code	Species	Habitats	Significance	Comments
	AMARANTHACEAE			
T-3	*Amaranthus pumilus* Raf. Seabeach Amaranth	Beaches, shores	NRL SPOR R	Sporadically distributed from Nantucket, MA to NC.
	AIZOACEAE			
T-3	*Sesuvium maritimum* (Walt.) B.S.P. Sea Purslane	Sandy shores	SPOR NRL R	A southern, coastal species, rarely found north of the Carolinas.
	MAGNOLIACEAE			
T-3	*Magnolia virginiana* L. Sweet Bay	Swampforest	NRL	A coastal plain species reaching northern limits NY, MA.
	CARYOPHYLLACEAE			
E-3	*Spergularia canadensis* (Pers.) G. Don Sand-spurrey	Saltmarshes and shores	SERL EXT?	A northern species not seen since 1887, but not conspicuous.
T-3	*Stellaria longipes* Goldie Starwort	Open woods	SERL	Ranges from Alaska to Greenland and southwestern states.
	NELUMBONACEAE			
E-3	*Nelumbo lutea* (Willd.) Pers. Yellow Lotus	Ponds, lakes	NRL VULN	A southern and midwestern species reaching northern limits; perhaps introduced in NY by Indians.
	RANUNCULACEAE			
E-3	*Clematis ochroleuca* Ait. Curly-heads	Woods, thickets, clearings	EXT? NRL VULN	Southern plant reaching northern limits on Staten Island.
E-3	*Ranunculus cymbalaria* Pursh Seaside Crowfoot	Brackish places	DECL VULN	Last seen 1927, but most of our records are 70-150 years old; habitats gone in central NY.
T-3	*Ranunculus micranthus* Nutt. Small-flowered Crowfoot	Woods, limestone	NRL	A southern species nearing northern limits.
E-3	*Ranunculus pusillus* Poir. Spearwort	Wet places	NRL	A southern and midwestern species at northern limits.
E-3	*Thalictrum dasycarpum* Fisch. & Llal. Purple Meadow-rue	Meadows	SNYS ERL	A primarily midwestern species.
T-3	*Thalictrum venulosum* Trel. Veiny Meadow-rue	Calcareous shores (NY)	SRL	A northern and western species reaching southern limits in NY, VT. (*T. confine* Fern.)
	FUMARIACEAE			
T-3	*Corydalis aurea* Willd. Golden Corydalis	Open woods, limestone	SPOR	Only three twentieth century locations verified, distributed mostly northwest of NY.
T-3	*Corydalis flavula* (Raf.) DC. Yellow Harlequin	Woods and elearings	NERL	A southern and Great Lakes species at n.e. limits, CT, NY.

APPENDIX II. CONTINUED

Status Code	Species	Habitats	Significance	Comments
	BRASSICACEAE			
T-3	*Arabis missouriensis* Greene Rock-cress	Bluffs, rocky woods	SPOR	A scattered distribution over northeast and midwest, south to GA.
E-3	*Arabis shortii* (Fern.) Gleason Rock-cress	Riverbanks, bluffs and ledges	NERL SNYS EXT? VULN	Appalachian and western, extending to KS and VA.
T-3	*Cardamine rotundifolia* Michx. Mountain Watercress	Streamsides	NRL	Southern and midwestern species at northern limits.
E-3	*Draba glabella* Pursh Draba	Calcareous shores	SRL VULN HAB	Arctic-circumboreal reaching southern limits. Only locations in the U.S.
	DROSERACEAE			
T-3	*Drosera filiformis* Raf. Dew-thread	Seeps and bogs	DECL VULN R END? or DISJ	A very local coastal species (MA to NJ) only on the tip of L.I. in NY; distinct from *D. tracyi* of SC to LA?
	PODOSTEMACEAE			
T-3	*Podostemum ceratophyllum* Michx. Threadfoot	Flowing water	SPOR	Swift streams where it is locally abundant.
	CRASSULACEAE			
T-3	*Sedum integrifolium* Raf. ssp. *leedyi* (Rosend & Moore) Clausen Roseroot	Cliffs and slopes	DISJ SPOR	Formerly treated under *S. rosea*; very rare in NY.
T-3	*Sedum rosea* (L.) Scop. Roseroot	Cliffs and fellfields	DISJ SPOR	Arctic-alpine circumboreal species, extending south to VA.
T-3	*Sedum telephioides* Michx. Live-forever, Orpine	Hills and cliffs	NRL	Appalachians to Illinois reaching northern limits.
T-3	*Tillaea aquatica* L. Water Pigmy-weed	Fresh water or tidal marshes	HAB SPOR	Widespread, worldwide, but sporadic in its distribution; often overlooked.
	SAXIFRAGACEAE			
T-3	*Saxifraga aizoides* L. Yellow Mountain Saxifrage	Cliffs and calcareous seeps	SRL HAB	Arctic-circumboreal reaching southern limits, NY, VT.
T-3	*Saxifraga paniculata* Mill. ssp. *neogaea* (Butt.) D. Löve Saxifrage	Cliffs, rocky hillsides	SRL HAB	European and American boreal element reaching southern limits in VT and NY (*Saxifraga aïzoön*).

APPENDIX II. CONTINUED

Status Code	Species	Habitats	Significance	Comments
	ROSACEAE			
T-3	*Geum vernum* (Raf.) T. & G. Spring Avens	Woodlands, clearings	NERL	Mostly Appalachian to midwestern reaching northeastern limits.
T-3	*Potentilla paradoxa* Nutt. Bushy Cinquefoil	Moist places, shores	ERL	A western species reaching eastern limits; also Asian.
E-3	*Rubus chamaemorus* L. Cloudberry, Knotberry	Alpine zone and beaches	DISJ SNYS SRL EXT?	An arctic disjunct to ME, NH peaks and Montauk (L.I.), NY.
	FABACEAE			
E-3	*Baptisia leucantha* T. & G. Prairie False Indigo	Clearings, prairies, woodland borders	DISJ SNYS NERL	A southern and midwestern species at northeastern limits; disjunct.
T-3	*Desmodium glabellum* (Michx.) DC. Tall Tick-clover	Sandy woods.	SNYS NERL	Plant of the midwest and southeast, reaching northeast limits NY, MA.
T-3	*Desmodium laevigatum* (Nutt.) DC. Smooth Tick-clover	Sandy woods	NRL	Southern and midwestern species at northern limits.
T-3	*Desmodium nuttallii* (Schindl.) Shub. Nuttall's Tick-clover	Dry woods	EXT? NERL	Last collected 1879, commonest around NY City; at northern limits; southern/midwestern (*D. viridiflorum*).
E-3	*Desmodium pauciflorum* (Nutt.) DC. Small-flowered Tick-clover	Rich woods	SNYS NRL	Southern and midwestern species at northern limits.
E-3	*Galactia volubilis* (L.) Britt. Twining Milk-pea	Thickets, borders	NERL EXT?	A southern and midwestern species reaching northern limits (last seen 1872).
E-3	*Strophostyles umbellata* (Muhl.) Britt. Wild Bean	Sandy places	NRL SNYS	A southern and midwestern species reaching northern limits on L.I.
	LINACEAE			
T-3	*Linum intercursum* Bickn. Wild Flax	Pine woods, sandy soil, downs	SPOR NRL HAB	Sporadic southern and midwestern species at northern limits NY, MA.
	GERANIACEAE			
T-3	*Geranium sphaerospermum* Fern. Geranium	Clearings, limestone	SERL	A western and northern species reaching southeastern limits.

APPENDIX II. CONTINUED

Status Code	Species	Habitats	Significance	Comments
	EMPETRACEAE			
E-3	*Corema conradii* Torr. Brown Crowberry, Broom Crowberry	Mountain ledges in NY (usually coastal sands)	SNYS SPOR DISJ HAB VULN	Somewhat vulnerable in its only NY location, in path on State land, with development proceeding nearby. Northern species (usually coastal) south to NJ.
	POLYGALACEAE			
T-3	*Polygala lutea* L. Yellow or Orange Milkwort	Moist, sandy places	NRL HAB	A coastal, southern species at northern limits.
E-3	*Polygala mariana* Mill. Pink Milkwort	Open sandy or peaty places	NRL SNYS	Southeastern coastal plain species reaching northern limits on L.I.
	CALLITRICHACEAE			
E-3	*Callitriche anceps* Fern. Water Starwort	Pools, shores	SNYS SRL	Arctic-alpine species at southern limits NY, NH, VT.
	CELASTRACEAE			
T-3	*Euonymus americanus* L. Strawberry-bush	Rich woods	NRL	Southern species at northern limits.
	HIPPOCASTANACEAE			
T-3	*Aesculus glabra* Willd. Ohio Buckeye	Low woods	NERL	Appalachian-ozarkian, reaching northeast limits.
	RHAMNACEAE			
T-3	*Ceanothus ovatus* Desf. Redroot	Rocky places, prairies, pinelands	HAB DISJ	Maine to Texas, local in the northeast
	HYPERICACEAE			
T-3	*Hypericum adpressum* Raf. Creeping St. John's-wort	Around ponds	NRL	Southern and midwestern; northern limits MA, NY.
E-3	*Hypericum densiflorum* Pursh St. John's-wort	Swamps	SNYS NERL	Southern and midwestern; northern limits, L.I.
E-3	*Hypericum gymnanthum* Engelm. & Gray St. John's-wort	Swamps, marshes, swales	NRL SPOR EXT?	Last seen 1902. A southern and midwestern element at northern limits on L.I.
T-3	*Hypericum hypericoides* (L.) Crantz St. Andrew's-Cross	Sandy places	NRL	Southern element reaching northern limits, L.I., MA.
	CISTACEAE			
T-3	*Lechea racemulosa* Michx. Pinweed	Sandy woods, barrens	NERL	Midwestern and seaboard, reaching northeast limits on L.I.
T-3	*Lechea tenuifolia* Michx. Pinweed	Sandy, rocky woods, clearings	HAB	Maine to Texas and midwest (L.I. only in NY)

APPENDIX II. CONTINUED

Status Code	Species	Habitats	Significance	Comments
	VIOLACEAE			
T-3	*Viola brittoniana* Pollard var. *pectinata* (Bickn.) Alex. Pectinate Violet	Meadows, thickets	HAB NRL	Uncommon coastal species at northern limits, L.I., MA.
T-3	*Viola hirsutula* Brainard Southern Wood Violet	Woods, clearings	NERL	Southern and midwestern at n.e. limits NY, CT.
T-3	*Viola stoneana* House Stone's Violet	Woods, thickets	NRL	Southern species reaching northern limits in NY.
	LYTHRACEAE			
T-3	*Lythrum lineare* L. Saltmarsh Loosestrife	Saline or brackish marshes	SNYS NRL	Southern coastal plain species at northern limits.
	MELASTOMACEAE			
T-3	*Rhexia mariana* L. Meadow Beauty	Damp, open places	NRL	Mostly coastal, southern species; northern limits, NY, MA.
	ONAGRACEAE			
T-3	*Epilobium ciliatum* Raf. Willow-herb	Cliffs, ledges, calcareous bogs	SRL	Boreal to alpine species widespread but scattered southward.
T-3	*Epilobium hornemannii* Reichenb. Willow-herb	Streams, rocky banks	SRL SNYS?	Circumboreal-arctic element reaching southern, alpine limits in the east, NY, NH.
	HALORAGACEAE			
T-3	*Myriophyllum alterniflorum* DC. Water Milfoil	Lakes, streams	SERL	A circumboreal species at southeast limits in NY, CT.
T-3	*Myriophyllum pinnatum* (Walt.) B.S.P. Green Parrot's-feather	Ponds, swamps	NRL	Reaching northern limits in NY, N.E.
T-3	*Proserpinaca pectinata* Lam. Mermaid-weed	Ponds, swamps	HAB	A coastal element, mostly on L.I. in NY.
	ARALIACEAE			
C-3	*Panax quinquefolius* L. American Ginseng	Rich woods	VULN DECL	Under severe collecting stress, in need of increased management.
	APIACEAE			
E-3	*Angelica lucida* L. Angelica	Coastal and sub-alpine meadows	SRL HAB	A circumboreal species reaching southern limits on L.I. (*Coelopleurum*).
T-3	*Berula erecta* (Huds.) Cov. Wild Parsnip	Wet places	ERL VULN	Western species reaching eastern limits on L.I.
T-3	*Chaerophyllum procumbens* (L.) Crantz Spreading Chervil	Rich woods	NERL	Ozarkian-Appalachian reaching n.e. limits in NY.

APPENDIX II. CONTINUED

Status Code	Species	Habitats	Significance	Comments
T-3	*Erigenia bulbosa* (Michx.) Nutt. Pepper and Salt, Harbinger of Spring	Rich woods	NRL	Reaching northern limits in NY, ONT.
E-3	*Hydrocotyle verticillata* Thunb. Pennywort	Lakes, river margins	NERL VULN	Western and southern, reaching limits in NY, N.E.
E-3	*Ligusticum scothicum* L. Scotch Lovage	Saltmarshes	EXT? SWRL VULN	Europe, Greenland to NY reaching southwestern limits on L.I.
T-3	*Oxypolis rigidior* (L). Raf. Cowbane	Swampforests, marshes, bogs	NERL	Southern, midwestern reaching n.e. limits in NY.
	PYROLACEAE			
E-3	*Pyrola minor* L. Mountain Pyrola, Shinleaf	Alpine woods, clearings	VULN SRL	Circumboreal-arctic species, reaching southern limits in our area.
	MONOTROPACEAE			
E-3	*Pterospora andromeda* Nutt. Pine-drops		DECL EXT? SPOR	Although there are numerous old records, this plant has been collected only twice since 1919. Once widespread but sporadic, now drastically declining.
	ERICACEAE			
E-3	*Cassiope hypnoides* (L.) D. Don Moss Heather	Peaks and fell-fields	EXT? SNYS SRL	Last seen (NY) 1879; southern range limits NH. Arctic-circumboreal *(Harrimanella)*.
E-3	*Loiseleuria procumbens* (L.) Desv. Alpine Azalea	Arctic-alpine, open sites	SRL	Circumboreal-arctic element reaching southern limits NY, NH.
T-3	*Rhododendron calendulaceum* (Michx.) Torr. Flame Azalea	Woodlands	NRL	Extreme northern sites for a primarily Appalachian species.
T-3	*Rhododendron lapponicum* (L.) Wahl. Lapland Rose-bay	Peaks, cliffs	SRL VULN	Circumboreal-arctic species ranging south to NH, NY peaks.
T-3	*Vaccinium caespitosum* Michx. Dwarf Blueberry	Summits (NY), gravelly places	SERL VULN	A western and northern species reaching southeastern limits.
	DIAPENSIACEAE			
T-3	*Diapensia lapponica* L. Diapensia	Summits, fellfields	SERL VULN	Circumboreal-arctic element reaching southern limits on peaks of NH, NY.
	PRIMULACEAE			
E-3	*Lysimachia quadriflora* Sims. Four-flowered Loosestrife	Swamps, bogs, limestone areas	ERL VULN	Inland species reaching eastern limits (old records).
T-3	*Primula mistassinica* Michx. Bird's-eye Primula	Limestone cliffs, seepage banks (meadows)	SRL SPOR HAB	Arctic to boreal species reaching southern limits.

APPENDIX II. CONTINUED

Status Code	Species	Habitats	Significance	Comments
	GENTIANACEAE			
E-3	*Gentiana procera* Holm Fringed Gentian	Boggy, calcareous meadows, swales	HAB EXT? ERL VULN	Northwestern entity reaching eastern limits in NY.
T-3	*Gentiana puberula* Michx. Prairie Gentian	Dry prairies, fields	ERL EXT?	A midwestern species ranging south to GA and east to NY.
T-3	*Gentiana saponaria* L. Soapwort Gentian	Swamps, shores	NRL EXT?	A southern and midwestern species at northern limits.
T-3	*Halenia deflexa* (Sm). Griseb. Spurred or Horned Gentian	Moist woods, bogs	SERL	Boreal plant reaching s.e. limits MA, NY (also Mexico).
T-3	*Sabatia campanulata* (L.) Torr. Slender Marsh-pink	Marshes, wet sand	NRL	Coastal plain species north to L.I. and MA coasts.
	ASCLEPIADACEAE			
E-3	*Asclepias rubra* L. Milkweed	Marshes, pinelands	NRL SNYS	A coastal plain species at northern limits.
T-3	*Asclepias viridiflora* Raf. Green Milkweed	Clearings, dry open grasslands	NERL	A southern and western species at northern limits. Sporadic in the northeast.
	POLEMONIACEAE			
E-3	*Phlox pilosa* L. Downy Phlox	Sandy woods, prairies	NERL	A southern and western species at northern limits. Sporadic in the northeast.
	HYDROPHYLLACEAE			
E-3	*Ellisia nyctelea* L. Ellisia	Moist woods, disturbed soil	EXT? SNYS NERL	Last seen (NY) 1899; western and southern (sometimes adventive)
E-3	*Phacelia dubia* (L.) Trel. Phacelia	Woods, thickets	SNYS NRL EXT?	A southern species, last seen (NY) in 1904.
	BORAGINACEAE			
T-3	*Hackelia americana* (Gray) Fern. Stickseed	Woods, clearings, limestone cliffs	SERL	Northern and western species at southeastern limits in NY, VT (circumboreal if considered a variety of *H. deflexa*).
E-3	*Lithospermum canescens* (Michx.) Lehm. Puccoon	Sandy woods, clearings	EXT? NERL	Last seen in 1890 in NY, southern and midwestern at n.e. limits in NY.
E-3	*Lithospermum croceum* Fern. Puccoon	Woods, clearings	EXT? ERL	Last seen 1883 in NY. Great Lakes and plains states east to NY.

Status Code	Species	Habitats	Significance	Comments
	LAMIACEAE			
T-3	*Blephilia ciliata* (L.) Raf. Wood Mint	Woods and clearings	NERL	A widespread species of eastern N.A. reaching northeast limits in VT, NY.
E-3	*Pycnanthemum clinopodiodes* T. & G. Mountain-Mint	Woods, shores, thickets	R SPOR EXT?	Last seen (NY) 1893; a sporadically distributed species from MA to DE.
T-3	*Pycnanthemum torrei* Benth. Torrey's Mountain-Mint	Dry woods	NERL	Apalachian-ozarkian at northeastern limits in NY, CT.
T-3	*Pycnanthemum verticillatum* (Michx.) Pers. Mountain-Mint	Clearings, swales, thickets	SNYS SPOR	Northeastern species with a scattered distribution.
E-3	*Satureja glabella* (Michx.) Briq. var. *angustifolia* (Torr.) Sven. Wild Savory	Damp cliffs, sandy places	SNYS? DISJ ERL	At its eastern limits. A Great Lakes and midwestern variety (*S. arkansana*).
E-3	*Scutellaria elliptica* Muhl. Hairy Skullcap	Woods, clearings	NRL EXT?	Last seen (NY) 1879; extirpated? Southern, midwestern reaching northern limits.
T-3	*Scutellaria integrifolia* L. Skullcap	Clearings, thickets	NERL	Reaching northern limits in N.E., NY; southern-midwestern.
E-3	*Scutellaria nervosa* Pursh Skullcap	Rich woods	SNYS? EXT? NERL	Last seen (NY) 1867; extirpated? Appalachian and midwestern at n.e. range limits.
E-3	*Trichostema setaceum* Houtt. Blue-curls	Sandy places	HAB NRL	A coastal plain species at northern limits in CT, NY.
	SOLANACEAE			
E-3	*Physalis grandiflora* Hook. Large, White-flowered Ground-cherry	Shores, clearings	EXT? SERL SNYS	Not seen (NY) since 1901; a boreal species reaching southeastern limits, NY, VT (*Chamaesaracha*).
T-3	*Physalis virginiana* Mill. Virginia Ground-cherry	Open woods, clearings	NERL	A species of the eastern U.S. reaching northeast limits, NY, CT.
	SCROPHULARIACEAE			
T-3	*Agalinis racemulosa* Penn. Gerardia	Pine barrens, bogs	NRL	Coastal plain species at northern limits
E-3	*Buchnera americana* L. Blue-hearts	Grasslands, open woods	DECL NERL	Not seen (NY) since 1910, Appalachian-ozarkian reaching northeast limits in NY, ONT.
	LENTIBULARIACEAE			
T-3	*Pinguicula vulgaris* L. Butterwort	Limestone seeps	SRL	Circumboreal; northern element reaching southern limits in NY, VT.
T-3	*Utricularia biflora* Lam. Two-flowered Bladderwort	Lakes, pools	NERL	Widespread species to the south and west, n.e. limits L.I. (*U. pumila*).

APPENDIX II. CONTINUED

Status Code	Species	Habitats	Significance	Comments
T-3	*Utricularia fibrosa* Walt. Fibrous Bladderwort	Ponds	HAB	A southern species reaching northern limits of MA.
T-3	*Utricularia radiata* Small Floating Bladderwort	Ponds	HAB	A southern species (to South America) reaching northern limits in N.S.
T-3	*Utricularia juncea* Vahl Rush Bladderwort	Wet, sandy or peaty places	NRL HAB	A southern coastal plain species; limit L.I.
	PLANTAGINACEAE			
T-3	*Littorella uniflora* (L.) Asch. Littorella, Shoregrass	Shores	SRL SPOR	Reaching southern limits; a northern and European species.
T-3	*Plantago pusilla* Nutt. Dwarf Plantain, Slender Plantain	Sandy clearings	HAB	Midwestern and southern with northeastern limits in N.E.
	RUBIACEAE			
E-3	*Galium concinnum* T. & G. Shining Bedstraw	Woodlands	SNYS NRL EXT?	Appalachian and midwestern reaching northern limits, NY.
T-3	*Galium kamtschaticum* Steller Northern Wild-licorice	Cool woods	SRL	A northern species at southern limits, NY, N.E.
T-3	*Hedyotis purpurea* (L.) Hook. Southern Bluets	Dry slopes	DISJ NERL	A southern plant at northern limits.
T-3	*Hedyotis uniflora* (L.) Lam. Clustered Bluets	Moist, open sites	NRL	A southern species at northern limits, L.I.
	CAPRIFOLIACEAE			
E-3	*Triosteum angustifolium* L. Feverwort, Horse-gentian	Woods, borders	SNYS NRL VULN	Reaching northern limits, L.I., CT; southern, midwestern.
T-3	*Viburnum edule* (Michx.) Raf. Squashberry	Rocky slopes, woods, thickets	SRL	Reaching southern limits in PA, NY. A northern species.
	ADOXACEAE			
T-3	*Adoxa moschatellina* L. Moschatel	Moist woods, clearings	DISJ SPOR SERL	A sporadically distributed northern, western and Eurasian species, disjunct at extreme eastern limits in N.A.
	VALERIANACEAE			
T-3	*Valerianella chenopodifolia* (Pursh) DC. Goosefoot Corn-salad	Meadows, fields	NERL	More western species reaching northeastern limits.
T-3	*Valerianella radiata* (L.) Dufr. Beaked Corn-salad	Open woods, fields, roadsides	NERL	Including *V. intermedia*; one NY collection (1939) this century. A southern and midwestern species.

APPENDIX II. CONTINUED

Status Code	Species	Habitats	Significance	Comments
E-3	*Valerianella umbilicata* (Sulliv.) Wood Corn-salad	Low, rocky woods	R NERL EXT?	Last seen (NY) 1855; southern and midwestern
	ASTERACEAE			
T-3	*Antennaria virginica* Stebb. Virginia Everlasting	Woods, clearings	R NRL	Last seen (NY) 1855, southern and midwestern.
E-3	*Arnica lanceolata* Nutt. Arnica	Alpine streambanks	VULN SERL	An alpine and western element reaching southeast limits NY, NH.
T-3	*Aster ciliolatus* Lindl. Aster	Streambank meadows	SERL	A western and northern species with s.e. limits in NY, N.E.
E-3	*Aster foliaceus* L. Aster	Meadows, shores	SNYS SRL	Boreal element at southern limits VT, NY, NH.
T-3	*Aster glomeratus* Bernh. Aster	Woods and thickets	SPOR EXT?	Not seen (NY) since 1915; ranging ME to VA.
T-3	*Aster radula* Ait. Aster	Swamps, marshes, bottomlands	SPOR HAB	Newfoundland to VA, scattered populations. L.I. only in NY.
T-3	*Bidens eatonii* Fern. Beggar-ticks	Estuary tidal flats and shores	SPOR SERL R	Known from Canada south to N.E. and NY; southeastern limits.
T-3	*Bidens hyperborea* Greene Estuary Beggar-ticks	Tidal flats and shores	SRL HAB	Reaching southern limits in NY, MA (formerly NJ).
T-3	*Cirsium altissimum* (L.) Spreng. Tall Thistle	Streambanks, meadows	NERL	A southern and midwestern species reaching n.e. limits in NY.
E-3	*Erigeron hyssopifolius* Michx. Daisy Fleabane	River bluffs	EXT? SRL SNYS	Not seen (NY) in 20th century. A northern species at southern limits.
T-3	*Eupatorium leucolepis* (DC.) T. & G. White Boneset	Open places	NRL	Western and southern widespread species reaching limits, NY, N.E.
T-3	*Gnaphalium purpureum* L. Purple Everlasting	Dry, open places	NERL	Western and southern widespread species reaching limits, NY, N.E.
E-3	*Liatris cylindracea* Michx. Blazing-star	Prairies	SNYS ERL EXT?	A central and midwestern species reaching eastern limits, NY, ONT.
T-3	*Polymnia uvedalia* L. Bearsfoot	Rich woods, clearings	NERL	Southern-midwestern reaching limits, NY.
T-3	*Prenanthes crepidinea* Michx. Rattlesnake-root	Clearings and thickets	NERL	Midwestern to Appalachians, at n.e. limits in w. NY.
T-3	*Prenanthes racemosa* Michx. Rattlesnake-root	Prairies, shores	ERL	A western species at eastern limits, NY, NJ. Not seen since 1917 (NY).

APPENDIX II. CONTINUED

Status Code	Species	Habitats	Significance	Comments
T-3	*Rudbeckia fulgida* Ait. Coneflower	Low, moist places	NERL	An Appalachian and midwestern species at northern limits. (*R. speciosa*).
T-3	*Silphium laciniatum* L. Compass Plant	Prairies, clearings	DISJ ERL SNYS	A prairie plant disjunct and at its eastern limit, NY.
T-3	*Solidago microcephala* (Greene) Bush Small-headed Goldenrod	Dry woods	NRL SNYS	A coastal plain species at northern limits, NY.
T-3	*Solidago rigida* L. Stiff-leaved Goldenrod	Fields, thickets	ERL	Coastal plain, prairie and southern species at eastern limits.

Appendix III. The New York State Protected Native Plant List

The list in Appendix III was enacted into State law in 1974 as a result of the efforts of a committee formed by the Department of Environmental Conservation. This committee was chaired primarily by Stanley J. Smith, at that time Curator of Botany at the New York State Museum. It sought the opinions of members of the State garden clubs, State agencies, universities and botanical institutions to determine which plants should be protected from gathering and commercial exploitation. The list should not be mistaken for a rare plant list, though some rarities are protected by it. Rather, it lists wild flowers and other plants (such as Dogwood, Azaleas and Trilliums) which are frequently gathered indiscriminately for flower arrangements, cultivation, or for momentary pleasure, and are then discarded. It was intended to discourage the gathering of plants on State and private land without permission. It underlines the fact that the plant life on a piece of land is the property and responsibility of the landowner, unlike wildlife which is managed by government agencies.

Protected Native Plants

Effective September 1, 1974, no one may knowingly pick, pluck, sever, remove or carry away, without the consent of the owner thereof, any protected plant. Violations of the law are punishable by fines of up to $25 each (Environmental Conservation Law § 9-1503). The following are native plants which shall be protected pursuant to the above law and state regulation (NYCRR § 193.3). Such list shall apply statewide.

COMMON NAME	SCIENTIFIC NAME
Green-dragon (Dragonroot)	*Arisaema dracontium*
Butterfly-weed (Chigger-flower; Orange Milkweed (Pluerisy-root)	*Asclepias tuberosa*
Bluebell-of-Scotland (Harebell)	*Campanula rotundifolia*
American Bittersweet (Waxwork)	*Celastrus scandens*
Pipsissewa (Prince's-pine; Waxflower) Spotted Evergreen (Spotted Wintergreen)	*Chimaphila spp.*
Flowering Dogwood	*Cornus florida*
Sundew (Daily-dew; Dewthread)	*Drosera spp.*
Trailing Arbutus (Ground Laurel, Mayflower)	*Epigaea repens*
Burning-bush (Wahoo) Strawberry-bush (Bursting-heart)	*Euonymus spp.* (Native)
All ferns, including: Adder's-tongue, Azolla, Buckhorn, Cliff Brake, Curly-Grass, Fiddleheads, Hart's-tongue, Maidenhair, Moonwort, Polypody, Rock Brake, Salvinia, Spleenwort, Walking-leaf, Wall-rue, Water-spangle, Woodsia.	
But excluding Bracken (*Pteridium aquilinum*); Hay-scented Fern (*Dennstaedtia punctilobula*); Sensitive Fern (*Onoclea sensibilis*), which are not protected.	*Filices* (*Filicinae: Ophioglossales* and *Filicales*) (Native)
Ague-weed, Blue-Bottles, Gentian (Gall-of-the-earth)	*Gentiana spp.*
Golden Seal (Orange-root; Yellow Puccoon)	*Hydrastis canadensis*
Holly (Hulver); Inkberry (Bitter Gallberry); Winterberry (Black Alder)	*Ilex spp.* (Native)
Laurel, Spoonwood (Calico-bush) Wicky (Lambkill)	*Kalmia spp.*
Lily, Turk's cap	*Lilium spp.* (Native)
Cardinal-flower (Red Lobelia)	*Lobelia cardinalis*
All Clubmosses, including: Bear's-bed (Christmas-green, Running Evergreen; (Trailing Evergreen; Ground Pine); Bunch Evergreen; Festoon Pine (Coral Evergreen; Buckhorn; Staghorn Evergreen, Wolf's-claws); Ground Cedar (Creeping Jenny); Ground Fir; Heath Cypress	*Lycopodium spp.*
Bluebell (Roanoke-bells; Tree Lungwort; Virginia Bluebell; Virginia Lungwort; Virginia Cowslip)	*Mertensia virginica*
American Bee-balm; Oswego Tea (Indian-heads; Scarlet Bee-balm)	*Monarda didyma*
Bayberry (Candleberry)	*Myrica pensylvanica*
Lotus (Lotus Lily; Nelumbo; Pond-nuts; Water Chinquapin; Wonkapin; Yellow Lotus)	*Nelumbo lutea*
Prickly Pear (Wild Cactus; Indian Fig)	*Opuntia humifusa* (*O. compressa, p.p.*)
All Native Orchids, including: Adder's-mouth (Malaxis); Arethusa (Dragon's-mouth; Swamp-pink;) Bog-candle (Scent-bottle); Calopogon (Grass-pink; Swamp-pink); Calypso (Fairy-slipper); Coral-root; Cypripedium (Lady's-slipper; Moccasin-flower; nerve root); Goodyera (Lattice-leaf; Rattlesnake-plantain); Kirtle-pink; Ladies'-tresses (Pearl-twist; Screw-auger); Orange-plume; Orchis; Pogonia (Beard-flower; Snake-mouth); Putty-root (Adam-and-Eve); Soldier's-plume; Three-birds. Twayblade; Whipporwill-shoe	*Orchidaceae*
Golden-club	*Orontium aquaticum*
Ginseng (Sang)	*Panax quinquefolius*
Wild Crabapple	*Pyrus coronaria*
Azalea; Great Laurel (White Laurel); Honeysuckle; Pinxter (Election-pink; Pinxter-bloom); Rhododendron (Rosebay); Rhodora	*Rhododendron spp.* (Native)
Bitterbloom (Marsb-pink; Rose-pink; Sabatia; Sea-pink)	*Sabatia spp.*
Bloodroot (Puccoon-root; Red Puccoon)	*Sanguinaria*
Pitcher-plant (Huntsman's-cup; Sidesaddle-flower)	*Sarracenia purpurea*
Wild Pink	*Silene caroliniana*
Bethroot (Birthroot; Squawroot; Stinking Benjamin; Wake-robin); Toadshade, Trillium	*Trillium spp.*
Globe-flower (Trollius)	*Trollius laxus*
Bird's-foot Violet	*Viola pedata*

Glossary

Adaptability—capability of surviving environmental change (see adaptation).

Adaptation—adjustment of organisms to environment; this may involve changes in individual form or function, or the term may be applied to genetic changes in populations and species over time.

Apomixis—(=Apogamy) reproduction without the fusion of sex cells, resulting in the production of new individuals.

Bipinnate—twice divided (compound) with leaflets arranged on each side of common stalks.

Bog—a wet place, usually covered with a peat moss (*Sphagnum*) mat, deriving its moisture primarily from the atmosphere. The term is often used loosely to include some types of fens, swales and marshes.

Calcareous—lime rich.

Calyx—the lower (outer) sterile series of flower parts (sepals).

Chromosomes—discrete nuclear bodies within cells which carry genetic materials and control cell function. A given species usually has a characteristic chromosome number.

Clove—a Catskill term for a steep-sided, often V-shaped valley which reminds one of the cloven hoof of an animal.

Clone—a series of genetically identical individuals, derived from the tissue of a single parent.

Damping-off—a disease which attacks young seedlings at ground level, often caused by the fungi *Pythium* and *Rhizoctonia*.

D.E.C.—an acronym for the New York State Department of Environmental Conservation, sometimes called EnCon.

Disjunct—(population) occurring outside the continuous range of the species, usually by considerable distance.

Downs—heavily grazed grassland (Montauk, Long Island once had such areas which were named for the downs of Great Britain).

Endangered—(plant species) near extirpation or extinction.

Endemic—restricted in distribution range.

Environment—components of an organism's surroundings which interact with it.

Estuarine—associated with an estuary—a body of water continuous with the ocean, often tidally influenced.

Fauna—animal life.

Fen—peat-forming wetland whose water supply contains nutrients from mineral soil water.

Flora—plant life; a flora is also a botanical treatment of an area.

Floret—a small flower; usually applied to one of a dense cluster, as in grasses.

Frond—a (fern) leaf; usually compound.

Habitat—immediate surroundings of an organism.

Heterozygous—genetically diverse (said of populations or species).

Homozygous—gentically homogeneous (said of populations or species).

Hummock—a small raised place, often caused by a growth of grass, sedge, rush or moss.

Ion—an electrically charged chemical group or particle.

Marl—a soil rich in calcium carbonate, clay and sand; sticky when wet, crumbly when dry.

Marsh—a place of saturated soil and standing water.

Mycorrhiza—association between a fungus and the roots of a plant; symbiotic or weakly parasitic.

Microclimate—a small climate within a larger one, the condition being caused by habitat irregularities.

Natural pavement—areas where the flat surfaces of bedrock strata are exposed.

Nature Conservatory, The (TNC)—a private, not-for-profit organization which purchases tracts of land for the purpose of their preservation in the natural state.

Niche—ecological space; often used to mean the place which an organism occupies (or may occupy within its tolerance limits).

Parasitic—drawing sustenance from another organism while living on or within it.

Palmate—with lobes or divisions radiating from a common point.

Pedicel—flower stalk.

Petaliferous—petal bearing.

pH—a measure of acidity/alkalinity; negative hydrogen ion concentration (14 pt. scale with 7.0 as neutral).

Physiography—configuration of the land (physical geography).

Pinnae—(pinna) leaflets of compound leaves of ferns.

Pinnate—(leaf) with leaflets arranged on either side of a common stalk; feather-like arrangement.

Plastic—(said of organisms) capable of modifying to compensate for environmental changes.

Pluvial—rainy, cool period.

Pteridophytes—ferns and related plants which reporduce by spores rather than seeds.

Rainshadow—a dry zone on the "down-weather" side of a ridge.

Rhizome—underground, usually prostrate stem.

Relict—(population) remnant of a formerly wider distribution.

Saprophytic—deriving nutrition from dead organic matter such as leaf litter.

Sepal—part or lobe of the calyx of a flower—one of the lowermost whorl of flower parts.

Serpentine—(soils) rich in magnesium silicate, weathering white to reddish or greenish.

Sori—(sorus) aggregations of sporangia on fern leaves.

Sporangia—(sporangium) small, spore-bearing organs; in ferns often helmet-like and opening explosively.

Spore—(as used here) reproductive cell of a non seed plant.

Stipe—stalk (of a fern frond).

Stream-capture—transfer of stream flow from one watershed to another by natural processes.

Substrate—(of a plant) the materials in which a plant is rooted.

Succession—progressive changes in the structure and species-composition of a biological community at a given site.

Swale—a marshy depression; often open with characteristic ground water flow.

Taxa—(taxon)—originally meaning taxonomic levels; now commonly used to mean species or organisms at those levels (such as members of species or varieties).

Taxonomy—the science of classification and processes leading to it.

Tetraploid—having four sets of chromosomes (or double the usual number).

Threatened—(plant species) likely to become endangered in the near future.

Tundra—turfy, open community of arctic and alpine climates.

Vegetative reproduction—propagation without the sexual process, such as cloning, suckering and apomixis.

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1981

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New York State Museum

The University of the State of New York
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Ranunculaceae
(Crowfoot Family)
of
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Richard S. Mitchell, Editor

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PREFACE

OUR GOAL in producing this series is to present a useful and authoritative account of the plants of New York State. These contributions are intended to reflect the knowledge and taxonomic opinions of specialists who prepare the manuscripts, while following a generalized format for consistency. Inclusion of ecological, distributional, medical and economic information on each species is also one of our major aims. Habitat references, flowering times, pertinent synonymy, etc., apply specifically to New York plants rather than to the entire ranges. Complete illustration should facilitate identification of specimens for those who are not formally trained in botany. Descriptions are original, ordered and as complete as possible to provide sequential cross-referencing.

Distribution maps accompany species of seed plants, ferns, mosses, lichens and some groups of fungi. These are plotted by counties to eliminate pinpointing endangered habitats, while offering an accurate visual picture of past collecting. Maps are based on the master file at the New York State Museum, Albany, and supplemented by available data (specimens examined by the authors) from herbaria housing significant New York collections. Specific data or literature citations for any map may be obtained, on approval, from the Museum.

We hope that these bulletins will serve individuals with interest in the flora, as well as to provide information for state and federal agencies, conservation organizations, industry and the scientific community. With these works go our hopes for the preservation and wise use of a precious and lifegiving resource—our state's plantlife.

Richard S. Mitchell, Editor

The New York State Flora Committee

The steering council of the New York State Flora Committee met for the first time on January 19, 1976, and established as its goals the promotion of study of the state's plant resources and the publication of this series of Museum Bulletins. These contributions will be continually updated after publication for possible incorporation into larger volumes at a later date.

Members of the council at the time of this publication are:

Richard S. Mitchell, Chairman, State Botanist, N.Y. State Museum, Albany (Vascular Plants)
Charles J. Sheviak, Curator of Botany, N.Y. State Museum, Albany (Vascular Plants)
Edwin H. Ketchledge, College of Environmental Science and Forestry, Syracuse (Bryophytes)
Clark T. Rogerson, New York Botanical Garden, New York (Fungi)
George J. Schumacher, Biology Department, SUNY, Binghamton (Algae)

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The classification system employed in this flora is that of Arthur Cronquist (1968), with modifications agreed upon through personal communication.

IMPORTANT NOTE

All economic uses, folklore, medical and pharmaceutical notes, uses as foodstuffs, etc., are compiled from the literature and do not represent an endorsement by the authors or the New York State Museum. Some of the uses may, indeed, be dangerous if incorrectly employed. Some are not effective and are presented for historical interest only.

LEGEND

FOR ALL MAPS IN THIS PUBLICATION THE FOLLOWING SYMBOLS APPLY:

Solid dot—specimen seen by author; data on file at the State Herbarium (NYS)

Circle—Field observation with location data and observers name on file (NYS)

Hollow triangle—Literature citation on file (NYS)

FOR ALL ILLUSTRATIONS IN THIS PUBLICATION THE FOLLOWING LETTER-DESIGNATIONS APPLY:

A. Habit sketch
B. Fruit
C. Fruit cluster
D. Rhizome (caudex)
E. Inflorescence
F. Flower
G. Seed
H. Leaf variant
J. Staminode
K. Receptacle
N. Nodal area
P. Petal

Ranunculaceae (Crowfoot Family)

The Ranunculaceae: a cosmopolitan family of annual and perennial herbs and vines (rarely subshrubs), particularly prominent in moist, cool-temperate floras. About 25 genera are found in North America, of which New York State has 16 native. Four genera, *Adonis*, *Nigella*, *Helleborus* and *Consolida*, are introduced, and also escape cultivation. Many species of this family are poisonous; some are extracted for narcotics or are otherwise important in internal medicine. The major way in which they are known, however, is in the horticultural trade. Some of the more important genera providing garden ornamentals are *Anemone* (Windflower), *Aquilegia* (Columbine), *Consolida* (Garden Delphinium), *Nigella* (Love-in-a-mist), *Adonis* (Pheasant's-eye), *Ranunculus* (Buttercup), *Helleborus* (Hellebore), *Aconitum* (Monk's-hood) and *Trollius* (Globeflower). Though members of the Ranunculaceae are primarily herbaceous, they find their closest relatives among the primitive woody plant families such as Berberidaceae and Magnoliaceae. Authors frequently find difficulty in reaching agreement on the limits and number of genera within Ranunculaceae. This is due in part to confusion of serial homology. A given part of a flower may be called staminode, honey-leaf or petal by different authors. What we have chosen to call perianth (a term used for the sterile envelope throughout this series) may be composed of sepals, petals, staminodes or elaborate flower-like nectaries in various combinations. These often serve to attract insects in a family whose pollination mechanisms are quite diverse. While many flowers are simple bee and fly pollinated types (eg. *Ranunculus*), there are trends within the family toward wind pollination (dioecism and polygamy) as well as adaptations to specialized pollinators. *Aquilegia canadensis* L. has an obvious adaptation to hummingbird pollination, while *Aconitum*, *Consolida*, *Delphinium* and *Nigella* have evolved hoods, spurs or specialized symmetry in conjunction with certain insect pollinators. Members of Ranunculaceae are found in an enormously varied range of habitats from alpine peaks to forest and swampland — from full, tropical sunlight to deep shade — but rarely in consistently dry habitats. Many species are water-loving, and a few are true, submerged aquatics.

FAMILY DESCRIPTION

Perennial or annual herbs or vines (rarely shrubby). Leaves are simple or compound, mostly alternate and estipulate, lobed, entire, cut or much-divided. Petioles may have sheathing bases. Flowers are typically bisexual (or plants may be polygamous to dioecious, as in *Thalictrum*). The perianth may be showy or inconspicuous and early-deciduous. It consists of two to many sepals which are often petaloid and showy, and may have up to two additional series of parts, variously called petals, honey-leaves or staminodia. Nectaries and nectary scales may also be present. Perianth parts are usually free, but they show some degree of adnation or cohesion in certain genera. Sepals are fused into a cup in some *Clematis* species. Flowers may have radial or bilateral symmetry, and the perianths of some genera are hooded or spurred. Stamens are usually many and spiraled (less commonly five or fewer). Ovaries are unicarpellate ranging from a few (rarely one) to hundreds, usually not cohering, often spiraling on the receptacle. The receptacle may be inconspicuous or may elongate to many times its original height in fruit. Fruits vary from several-seeded follicles to achenes or berries borne sessile or stipitate. In some genera they are plumose and wind dispersed. Seeds have a minute embryo and copious liquid to solid endosperm.

KEY TO GENERA

1. Plants not vining or woody at the base .... (3)
1. Plants vining or woody toward the base .... (2)
    2. Perianth of a single whorl of 4 (-6) parts; vines or suffrutescent herbs; roots not yellow .... *Clematis* (p.)
    2. Perianth of a whorl of 5 petaloid parts and an inner whorl of 5 staminodes; subshrubs with yellow roots .... *Xanthorhiza* (p.)
3. Plants aquatic, the submerged leaves branched-filamentous .... *Ranunculus* (p.)
3. Plants without submerged, branched-filamentous leaves .... (4)

4. Flowers with more or less showy perianth parts.. (9)
4. Perianth parts inconspicuous and early-deciduous or lacking; flowers mostly of stamens and/or ovaries.. (5)
5. Receptacle enlarging in fruit to make the head of achenes convex to spheroid or even cylindric..*Ranunculus* (p.)
5. Receptacle not enlarging beneath the achenes (or fruit berries or follicles) .... (6)
6. Leaves simple, broadly palmately lobed and toothed; each plant with a solitary flower; roots yellow ....*Hydrastis* (p.)
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7. Inflorescence a much-branched, diffuse panicle; plants often polygamous or dioecious ....*Thalictrum* (p.)
7. Inflorescence a simple or (1–3) branched raceme; plants with consistently bisexual flowers............. (8)
8. Racemes simple, unbranched, mostly 3–15 cm tall; berries and their pedicels showy red, pink or white ....*Actaea* (p.)
8. Racemes branched, mostly 15–60 cm tall; fruit of brownish follicles on short, brown pedicels ....*Cimicifuga* (p.)
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9. Perianth with one or more arched, nectary-bearing spurs ....(10)
10. Spur 1,; flowers bilaterally symmetrical..*Consolida* (p.)
10. Spurs 5; flowers radially symmetrical ....*Aquilegia* (p.)
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13. Major leaves simple or lobed, not deeply cut or compound (or lacking at flowering time).............(14)
14. Flowers white, pink or blue-purple; follicle cluster subtended by a 3-parted involucre on a hairy, leafless stalk..*Hepatica* (p.)
14. Flowers pale to dark yellow; fruit of achene or follicle clusters on pedicels from leafy stems.......(15)
15. Perianth of a single whorl of showy parts; fruit follicles ....*Caltha* (p.)
15. Perianth of calyx and corolla; fruit achenes ....*Ranunculus* (p.)
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16. Flowers yellow, yellow-green or orange-red..(17)
17. Stem leaves profusely linear-dissected ....*Adonis* (p.)
17. Stem leaves not linear-dissected ....(18)
18. Perianth of two whorls; petals yellowish, calyx greenish; staminodes absent; fruit achenes..*Ranunculus* (p.)
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19. Flowers mostly 2–2.5 cm broad; staminodes obovate-clavate, with blunt, thickened tips, becoming strap-like with age ....*Trollius* (p.)
20. Leaves and bracts linear-dissected, much-branched; fruit cluster globose, 3–4 cm in diameter..*Nigella* (p.)
20. Leaves and bracts not linear-dissected; fruit clusters less than 2 cm wide, usually much smaller....(21)
21. Flowers solitary on leafless scapes; leaves trifoliate; roots slender, fibrous, golden ....*Coptis* (p.)
21. Flowers borne on leafy stems; leaves ternately compound or deeply lobed; stems arising from a rhizome, caudex or tuberous rootstock which is not conspicuously yellow..(22)
22. Leaves of 3 to many palmately incised segments; stigma small but capitate ....*Anemone* (p.)
22. Leaves twice ternately compound (or more) with rounded leaflets; stigmas not capitate...........(23)
23. Flowers borne in a terminal umbel; fruit of strongly-ribbed, sessile achenes (4–15 in number) ....*Anemonella* (p.)
23. Flowers borne singly, terminal and axillary; fruit of weakly-ribbed, short-stipitate, divaricate follicles (usually 4) ....*Isopyrum* (p.)

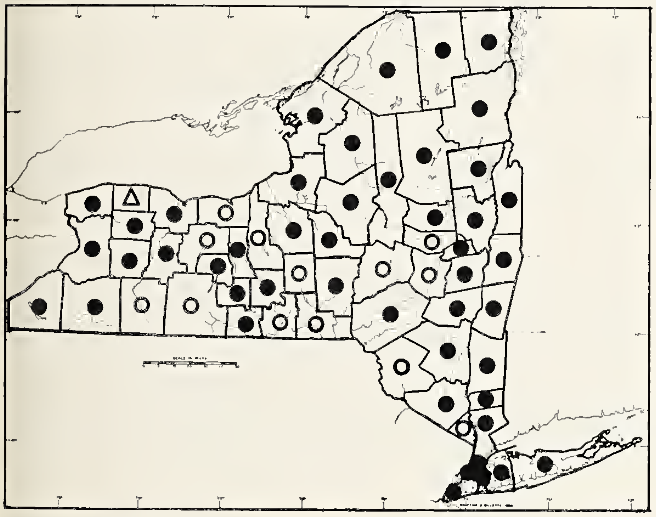
1. CALTHA

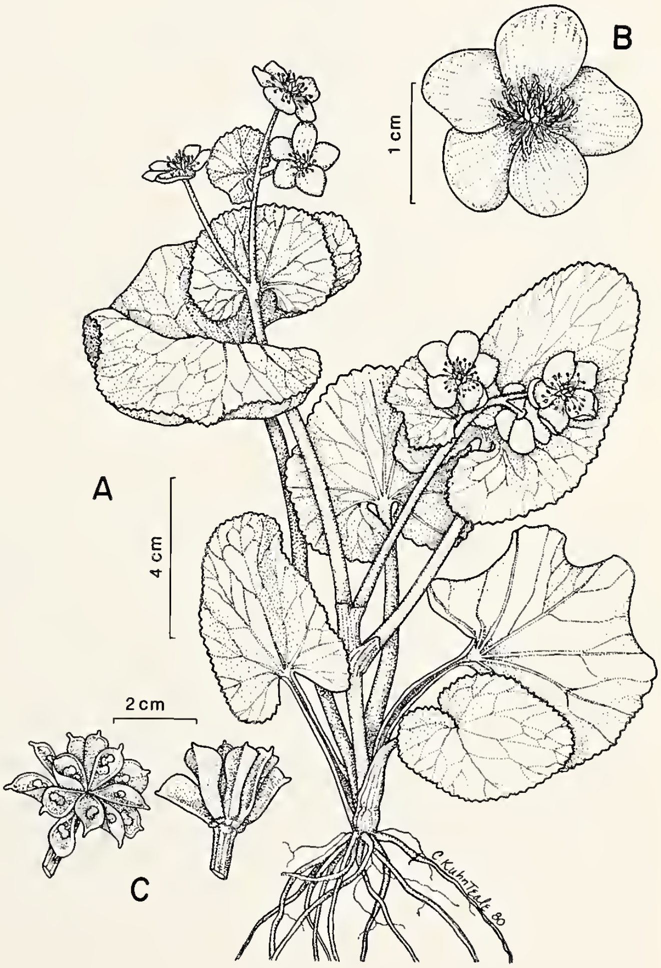
Common Names: Marsh Marigold, Cowslip, Elkslip, May-blob

Authority: Linnaeus, Species Pl., p. 558, 1753

A genus of about 15 species in temperate and arctic climates circumboreally. The common species of the boreal northern hemisphere, *Caltha palustris,* grows in wet places, but is not a true aquatic like the rarer (but also circumboreal) *C. natans* which has floating leaves. Elkslip, *C. leptosepala,* is the most widespread montane species of western North America. The plants are poisonous when raw, but are often boiled as pot herbs.

Description: Plants with **bisexual** flowers; **stigma** and **style** 1 per ovary, minute, but enlarging in fruit; **ovaries** free, (4) 5—30 or more, with many **ovules** and marginal placentation, becoming sub-terete to compressed, many-seeded **follicles** in a cluster; **seeds** with copious **endosperm; embryo** small; **stamens** numerous; **staminodes absent; perianth** parts free, 5—9 (10), in a single spiral series, yellow, orange, white, pink or bluish; **flowers** several to many per plant, borne singly on stout **peduncles** from the leaf axils from the base or near the tips of the plant; **basal** leaves often larger than the cauline ones with reduced petioles upward; **leaves** cordate, reniform, oval or elliptic, toothed or entire; **petioles** very short to many times the length of leaves; **stipules** partially sheathing the stem; **stem** a basal caudex or elongate to sprawling (floating); **roots** spongy, pale, fleshy.





1. *Caltha palustris* L.

Common Names: Marsh Marigold, Cowslip, King-cup, May-blob, "Cowlily"

Type Description: Linnaeus, Species Pl., p. 558, 1753

Synonyms: *Caltha flabellifolia* Pursh, *C. radicans* Forst., *C. parnassifolia* Raf., *C. integerrima* Pursh, *C. palustris* var. *radicans* (Forst.) Hartm., *C. palustris* var. *integerrima* (Pursh) T.&G., *C. palustris* var. *flabellifolia* (Pursh) T.&G.

Origin: Arctotertiary Forest (wetlands)

Habitats: Boreal and arctic marshes, swamps, wet meadows, ditches, swales and bog margins

Habit: Erect to decumbent, perennial herbs

Flowering: April—June

Fruiting: May—August

General Distribution: Labrador to Alaska and Eurasia, south to Nebraska and South Carolina

Description: Plants with **bisexual** flowers; **stigma** 1 per ovary, diffuse; **style** 1 per ovary, short, enlarging in fruit; **ovaries** (4) 5—12 (14), compressed-fusiform, 2—4 mm long, 1 mm wide, with numerous **ovules** and marginal **placentation**, becoming many-seeded, keeled follicles in **fruit**; **follicles** (4) 5—12, in a cluster, each 1.0—1.8 cm long, veiny, divergent, with a persistent **stylar beak**, dehiscing along an adaxial suture, follicles forming a green and tan, rosette-like crown of spent fruit after dehiscence; **seeds** elliptic, 2.0—2.5 mm long capped with floatation tissue, copious **endosperm** surrounding a small **embryo**; **nectaries** present between the ovary bases and inner filaments; **stamens** numerous, 5—7 mm long, spiraling; **filaments** slender, somewhat flattened; **anthers** 2-celled, basifixed, dehiscing by longitudinal slits; **perianth** of a single spiraling series of unfused parts; **perianth lobes (sepals)** 5—9, broadly oval to narrowly oblong, rounded to obtuse, pale to bright yellow or yellow-orange, 1—2 cm long, 0.8—1.5 cm wide, with many strong, dichotomous veins; **flowers** 1.4—3.1 (3.6) cm broad, borne singly, often in pairs from the axils of upper leaves; **bracts absent**; **peduncles** ridged and fluted, glabrous, 2—8 (10) cm long; **cauline leaves** alternate, progressively smaller and shorter petioled, the uppermost almost sessile, triangular-cordate to ovate, dentate, serrate or almost entire; **basal leaves** with cordate to truncate bases, reniform to oval, 6—15 cm long and wide, serrate, dentate, crenulate or almost entire, often shiny, leathery with **petioles** 6—18 cm long; all leaves with **hydathodes**; **petioles** ribbed 0.1—18.0 cm long, glabrous, their bases partially sheathing the stem, the larger ones lanceolate-auriculate; **stems** hollow, somewhat spongy, furrowed and grooved, glabrous, erect or decumbent, up to 80 cm tall, from a thick, perennial base covered with a mass of pale, spongy **roots.** (2n = 32 in North America, many ploidy levels in Europe).

Infraspecific Variation: It is not clear whether variations in habit and leaf shape reflect racial differences or are phenotypically induced by shading, water flow, temperature etc. Typical var. *palustris* has a stout, erect stem and broad basal leaves whose well-developed lobes may close or overlap the sinus; in contrast, so-called "var. *flabellifolia*" has a decumbent habit, often sprawling in cold streams, and the leaves are wedge-shaped with broad sinuses (truncated in the extremes). Intermediates appear numerous, but further study is needed. Leaf margins also show a wide range of crenulation, serration and dentation; in some populations most upper leaves are deeply and sharply toothed, giving a totally different aspect to the plants.

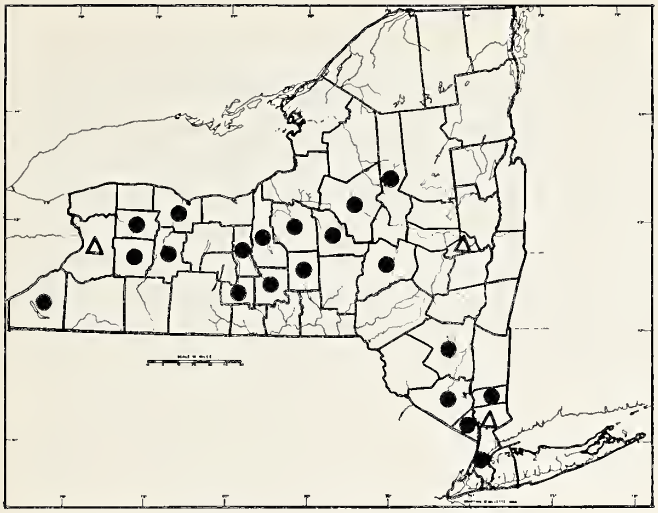
Importance: The fresh herb is distasteful and poisonous, containing the irritant oil Protoanemonin and the deadly glucoside Hellebrin, but these break down with boiling. Young plants have been commonly boiled as pot herbs in New York and New England. Care must be taken to avoid the stipules and mucilagenous stem bases, and the water must be changed at least once to rid the dish of an acrid taste and the extracted poisons. Another danger is the presence of other poisonous plants in the habitats where they grow, but they look like little else. Marsh Marigold is much feared and avoided in Europe, where it is perhaps more toxic. Juice of the petals, boiled with alum, has been used to produce a yellow dye.

2. TROLLIUS

Common Name: Globeflower

Authority: Linnaeus, Species Pl., p. 556, 1753

A genus with about 15 species in Eurasia and one in boreal North America. *Trollius riederianus* reaches the Aleutian Islands, and *T. europaeus* escapes cultivation in Canada. *Trollius laxus*, the only truly North American species, has yellow flowers in the east and a white-flowered variety in the west. These are cultivated in wet places, as are about 10 Eurasian species. *Trollius laxus* is rare and threatened throughout the range of its eastern variety, being best represented in numbers in New York State.



1. *Trollius laxus* Salisb.

Common Names: Spreading Globeflower, Globeflower
Type Description: Salisbury, Trans. Linn. Soc., vol. 8, p. 303, 1803

Synonyms: *Trollius americanus* Muhl. (*nomen nudum* cited by DC.), *Gaissenia verna* Raf.

Origin: North America

Habitats: Open swales on marly hummocks, wet woodlands, swamps, borders, clearings; calcareous, saturated soils

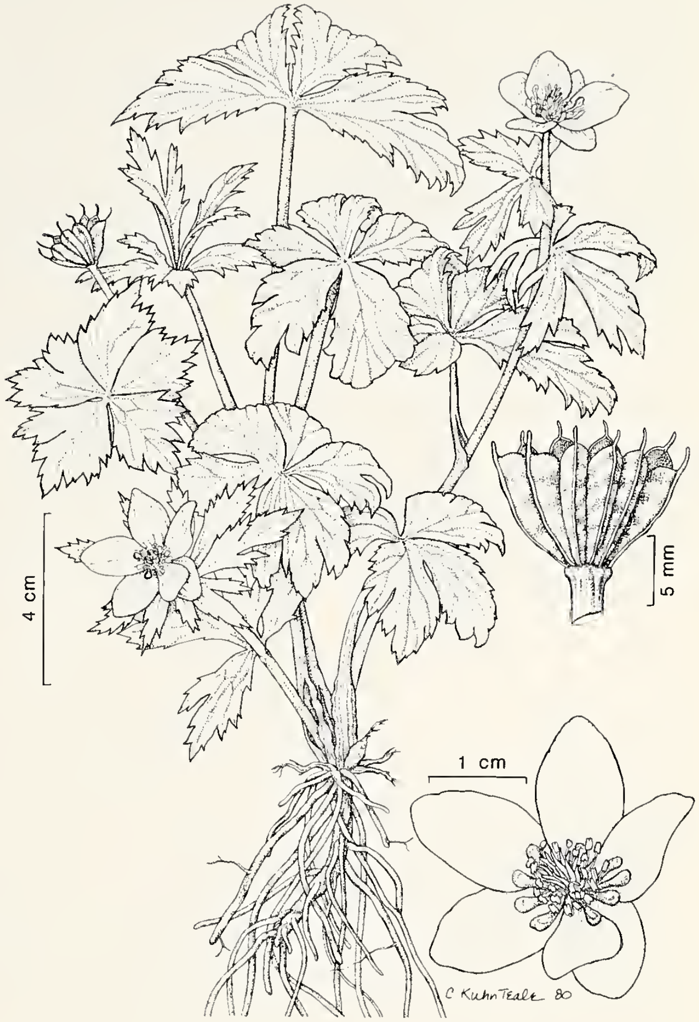
Habit: Erect or spreading perennial herbs

Flowering: April—May (early June, rarely September)

Fruiting: May—July

General Distribution: Connecticut, New York, Pensylvania, Ohio, Michigan (var. *albiflorus* in the Rockies westward)

Rarity Status: Threatened in the eastern United States; protected in New York State



Description: Plants with **bisexual** flowers; **stigmas** minute, 1 per ovary; **style** 1, per ovary slender, ca 3 mm long; **ovaries** 5—12, fusiform, slightly enlarged dorsally, 3—4 mm long, with numerous **ovules** in each, the **ovaries** becoming many-seeded **follicles** in fruit; follicles brown, borne in a cluster of 5—12, thin-walled, veiny, 0.8—1.2 cm long, swollen on their dorsal surfaces and with persistent styles; **stamens** 20—35, upcurved, becoming straight and spreading to alternate with the staminodia at dehiscence, outer stamens longer than inner ones; **filaments** slender, 3—6 mm long; **anthers** linear, borne laterally, ca 1.5 mm long; **staminodia** 8—18 (25), golden-yellow, waxy, clawed and upcurving, oblong-hexagonal to strongly spatulate, often obscurely 2—lobed, 3—5 mm long, starchy in texture, nectariferous at bases; **perianth** of a single series of 4–6 petal-like lobes, showy, 1.4—3.5 (4) cm broad, ultimately spreading, the **lobes** (**sepals**) oval-elliptic, with rounded to obtuse tips, at first greenish, becoming bright to pale or creamy yellow, with greenish veins, 0.6–1.8 cm long, 0.8–1.5 cm wide; **flowers** borne singly at branch tips; **peduncles** stout, glabrous, ridged, a continuation of the stem (which is not ridged); **cauline leaves** palmate, of (3) 5 or more narrowly obovate lobes, toothed and irregularly incised, glabrous, 2—6 cm in diameter, those nearest the flowers bract-like, sub-sessile; **basal leaves** similar to cauline ones, but segments much broader, especially near the tips, 3—18 (25) cm in diameter, long-petioled, often equaling or overtopping the flowers; **petioles** slightly clasping, glabrous, 0.1—25.5 cm long, shorter upward on the stem; **stipules** mostly at plant base, clasping and somewhat sheathing the stems and lower petioles; **stems** glabrous, 10—25 (38) cm tall, the **branches** smooth or obscurely ribbed; **stem base** perennial with tough, somewhat fleshy **roots.** (2n = 32)

Infraspecific Variation: Perianth color varies from bright yellow to cream in the eastern United States (var. *laxus*) and from creamy yellow to white in the west (var. *albiflorus* A. Gray). Leaves are extremely variable in size, lobing and toothing. In habit the plants may vary from dense, round-topped clumps near the ground to erect, delicate, single plants. Flowering stalks may have up to three bract-like leaves. Staminodes may be plump, dark yellow and waxy to linear and almost petal-like.

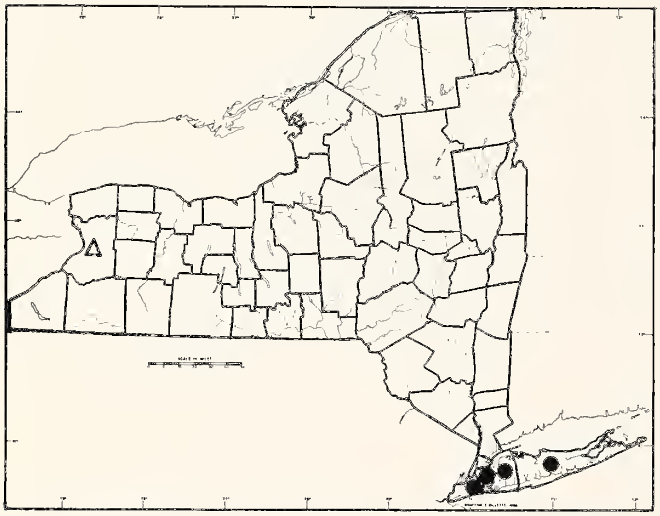
Importance: This rare, native plant is sometimes cultivated in moist places. It is vulnerable to exploitation and deserves protection. Though western-central New York appears to be the center of its distribution in the eastern United States, many sites formerly known are destroyed, especially in New York State's southeastern counties. *Trollius* is reported to contain poisonous alkaloids, as in *Ranunculus*.

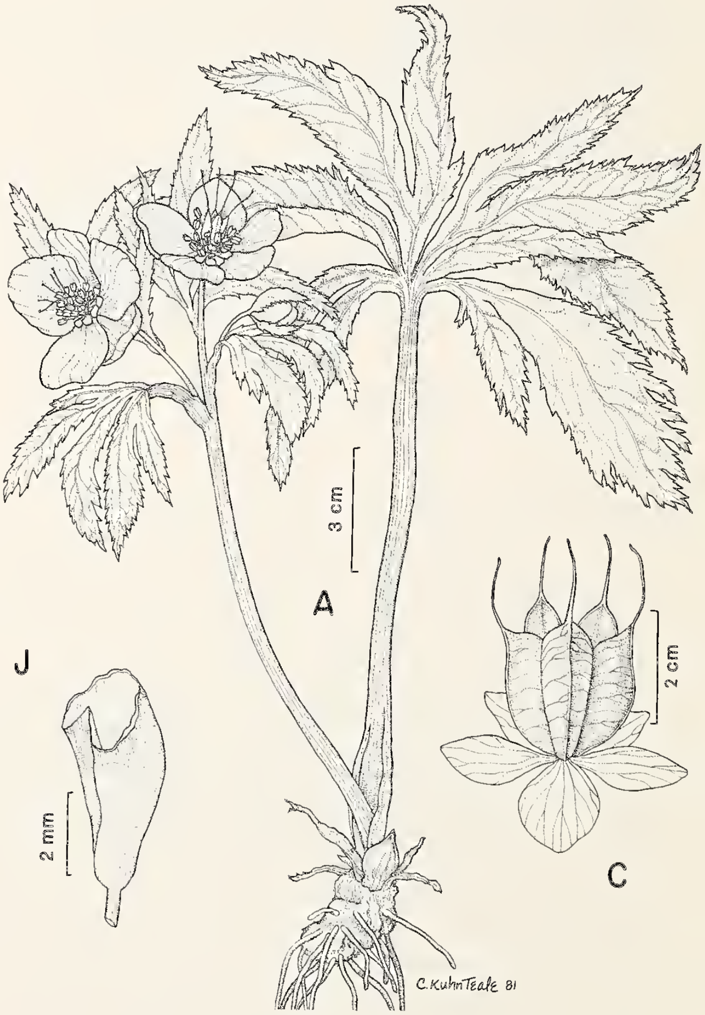
3. HELLEBORUS

Common Name: Hellebore

Authority: Linnaeus, Species Pl., p. 557, 1753

A genus of about 20 species of perennial herbs. They are native to calcareous regions of Eurasia, and many species are widely cultivated in cool climates. They are cold-resistant, blooming in fall, winter or early spring, even before *Scilla* and *Crocus*. These are some of the most poisonous of cultivated plants. Although several species are grown in New York State, only one has been reported as a persistent escape.





1. *Helleborus viridis* L.

Common Name: Green Hellebore

Type Description: Linnaeus, Species Pl., p. 558, 1753

Origin: Europe

Habitats: Waste places, shaded roadsides and calcareous woodlands as an escape

Habit: Erect, perennial herbs

Flowering: March—April (winter thaws)

Fruiting: April—June

General Distribution: An occasional escape in boreal North America; a native of Europe

Description: Plants with **bisexual** flowers; **stigma** 1 per ovary, capitate; **style** 1 per ovary, slender, 0.7—1.4 cm in length, curved, persistent in fruit; **ovaries** 3—5, slender, 5—9 mm long, bearing numerous **ovules**, becoming inflated, many-seeded **follicles** in fruit; follicles borne in clusters of 3—5, swollen, with transverse veins, 1.5—2.0 cm long (excluding the persistent style); **stamens** 30 or more, slender; **filaments** 5—10 mm long; **anthers** 1.5 mm long; **staminodes** ("petals") small, 5—9, upwardly curved, cornucopia-like, with in-rolled margins and undulate tips; **sepals** 5, in a single series, petal-like, free, yellowish-green, 2—3 cm long, 1—2 cm broad, oval-elliptic, with obtuse to acuminate tips; **flowers** (3.5) 4—6 cm in diameter, borne singly or more often in pairs or clusters of 3 (4) at the branch tips; **peduncles** stout, ribbed, glabrous to glandular-puberulent; **cauline leaves** petiolate or sub-sessile (those subtending peduncles), pedately lobed with oblanceolate, sharply serrated leaflets 2—10 cm long, 0.5—2.0 cm wide, unlobed, bifid or less commonly incised; **basal leaves** similar but long-petioled, larger (up to 40 cm wide), the **lobes** 8—21 cm long, 1.5—4.2 cm wide; **petioles** ridged, up to 30 cm long; **stipules** basal, clasping, obtuse to acute, 2.5—3.5 cm long, ca 1 cm wide; **stem** fluted and ridged, 15—30 cm tall, from a tough perennial **rhizome** and brittle **rootstock.** (2n = 32)

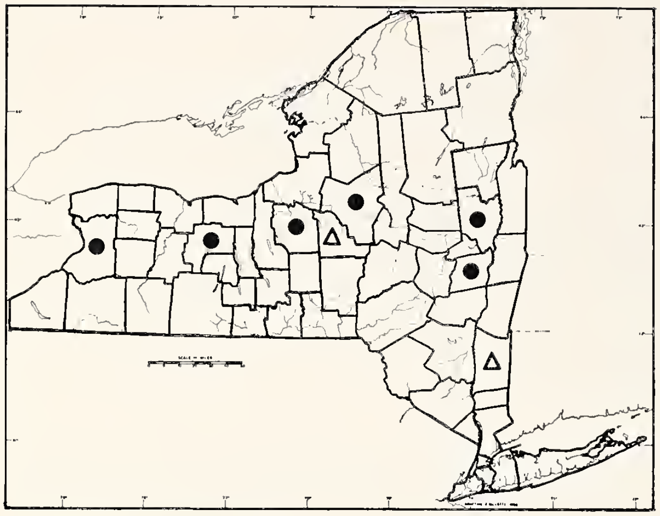
Importance: This species is not as common in cultivation as it once was, and has not been reported as an escape recently. Christmas-rose, *H. niger*, is more popular due to its showy, white to pinkish flowers; it was reported to escape once in 1880 at Sennet, N.Y., Cayuga County. Both living and dry plants of all Hellebores are extremely poisonous. Poisoning from contaminated hay is a major cause of cattle deaths in some areas. The plants contain cardiac glycosides, which act directly on the heart muscle, causing convulsion in addition to purging, delirium and eventual death. The main cardiac stimulant is Hellebrin.

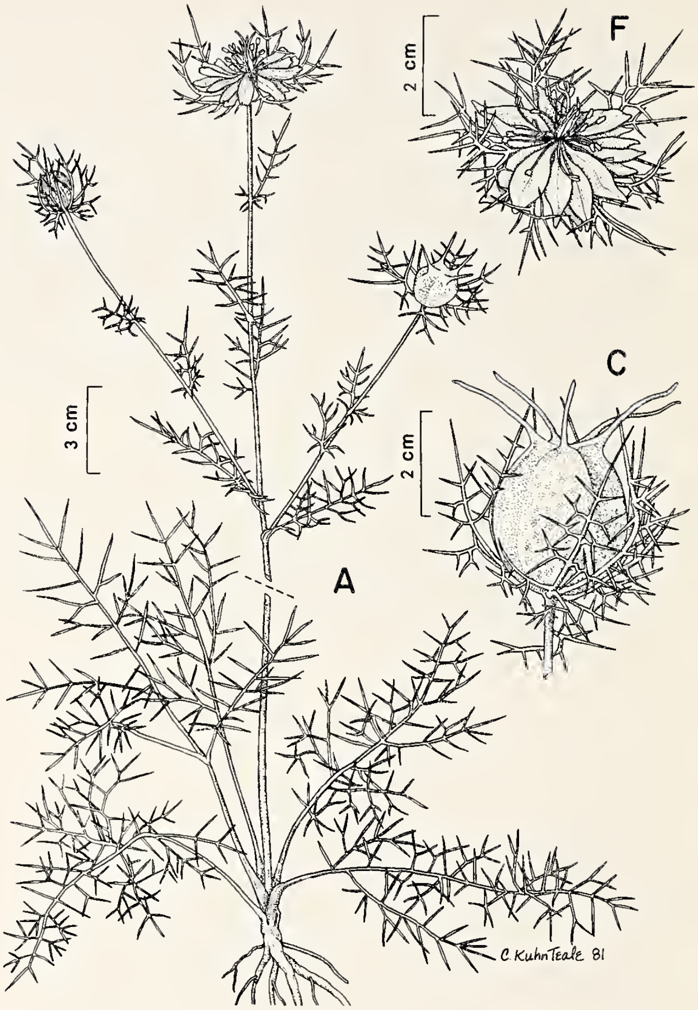
4. NIGELLA

Common Names: Fennel-flower, Love-in-a-mist

Authority: Linnaeus, Species Pl., p. 534, 1753

A genus of 15—20 species native to the Mediterranean region and western Asia. A number of species are cultivated and become self-seeding annuals within gardens, but *N. damascena* is the only one reported as an escape in New York State.





1. *Nigella damascena* L.

Common Names: Love-in-a-mist, Fennel-flower, Love-in-a-puzzle, Ragged Lady

Type Description: Linnaeus, Species Pl., p. 534, 1753

Origin: North Africa (also found in southern Europe)

Habitats: Waste places, roadsides, cultivated ground as an escape

Habit: Erect or spreading, annual herbs

Flowering: May—August

Fruiting: June—October

General Distribution: An uncommon garden escape in boreal North America, native to southern Europe and North Africa

Description: Plants with **bisexual** flowers; **stigma** 1 per ovary, in somewhat twisted area of the upper **style**; style 1 per ovary, slender, winged, 5—6 mm long, becoming 1.5—2.0 cm long and persistent in fruit; **ovaries** 5—7 (10), partially coherent, 5—6 mm long, slender, each with a number of **ovules**, becoming an inflated, many-seeded **follicle** in fruit; follicles fused into a red-brown, globe-like cluster 2.1—3.5 cm long (excluding styles), 1.8—3.1 cm wide, dehiscing apically; **seeds** ca 1 mm in diameter, dark brown, **stamens** numerous, slender; **filaments** 1—1.5 cm long; **anthers** 2 mm long; **petals** (also called **staminodes** or **honey-leaves**) flower-like, ca 7 mm long, stalked, tubular at the base with a lower lip and two flared upper ones, villous-bearded within and nectariferous, **or** tubular at base, expanded-lacerate at tips, **or absent; sepals** free, petal-like, white to bluish, lance-ovate to oval, obtuse, 0.6—1.7 cm long, about half as broad; **flowers** single at the branch tips, 2—4 cm broad; **involucre** dissected like the leaves, closely subtending the flower, 3.0—5.5 cm broad; **leaves** 2—12 cm long, alternate, pinnately to bipinnately, finely dissected into narrowly linear segments; **petioles** 0—8 cm long; **stipules absent; stem** ribbed, erect or spreading 15—30 cm from a slender, annual **taproot.** ($2n = 12$)

Infraspecific Variation: The differences in petal types found in our materials are striking. Breeding may be responsible for this variation, since all our 19th century materials have a complex petal type and more recently collected materials have a simple petal type or none at all. The most closely related species cultivated in our area is *N. arvensis*, in which there is no involucre. Flowers of both these species range from white to bluish.

Importance: *Nigella damascena* has been a favorite in old-fashioned yard plantings, as a border, or seeded in several times during a season to fill unused garden space. Like its relative *N. sativa*, its seeds are used as a pungent spice and called "fennel".

5. CIMICIFUGA

Common Names: Bugbane, Rattletop

Authority: Linnaeus, Syst. Nat., ed. 12, p. 659, 1769

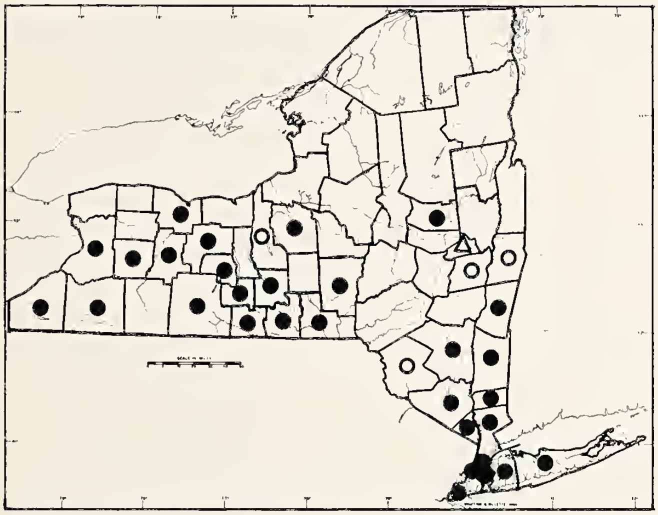
A genus of about 20 species, mostly in eastern Asia, with six in North America. *Cimicifuga racemosa* is native to New York State, and though *C. americana* has been reported, no specimens have been found. Members of the genus have a spotty history of use in folk medicine, and some have been used as natural insect repellent.

Description: Plants with **bisexual** flowers; **stigma** and **style** 1 per ovary, persistent; **ovaries** 1—8, stalked in some species, forming dry, dehiscent, several-seeded **follicles** in fruit; **stamens** numerous, with pale, slender **filaments** and small, yellow **anthers**; **staminodes** 1—9, bifid; **perianth** of 4 or 5 petaloid parts which are deciduous at anthesis; **pedicels** often upcurved in fruit; **inflorescences** are elongated, simple or branched racemes; **leaves** ternately to multiply compound or simple-pinnate; **leaflets** broad, toothed, serrated or often lacerate; **petioles** ribbed; **stems** up to several feet tall, from a tough, perennial **rhizome** system and fibrous **roots.**

KEY TO SPECIES

1. Ovaries 3, 5 or 8, basally stalked; stigma (in fruit) minute, on a pointed style; seeds with a chaffy covering .... *Cimicifuga americana* (report only)

1. Ovaries single (very rarely 2—3), not stalked; stigma (in fruit) knob-like or blunt, on a stout style; seeds with rough sides, but not chaffy .... 1. *Cimicifuga racemosa* (p.   )



1. *Cimicifuga racemosa* (L.) Nutt.

Common Names: Black Snakeroot, Black Cohosh

Type Description: Linnaeus, Species Pl., p. 504, 1753

Synonyms: *Actaea racemosa* L., *Macrotrys actaeoides* Raf., *M. racemosa* (L.) Sweet, *Cimicifuga serpentaria* Pursh, *Thalictrodes racemosum* (L.) Kuntze

Origin: Circumboreal Arctotertiary Forest

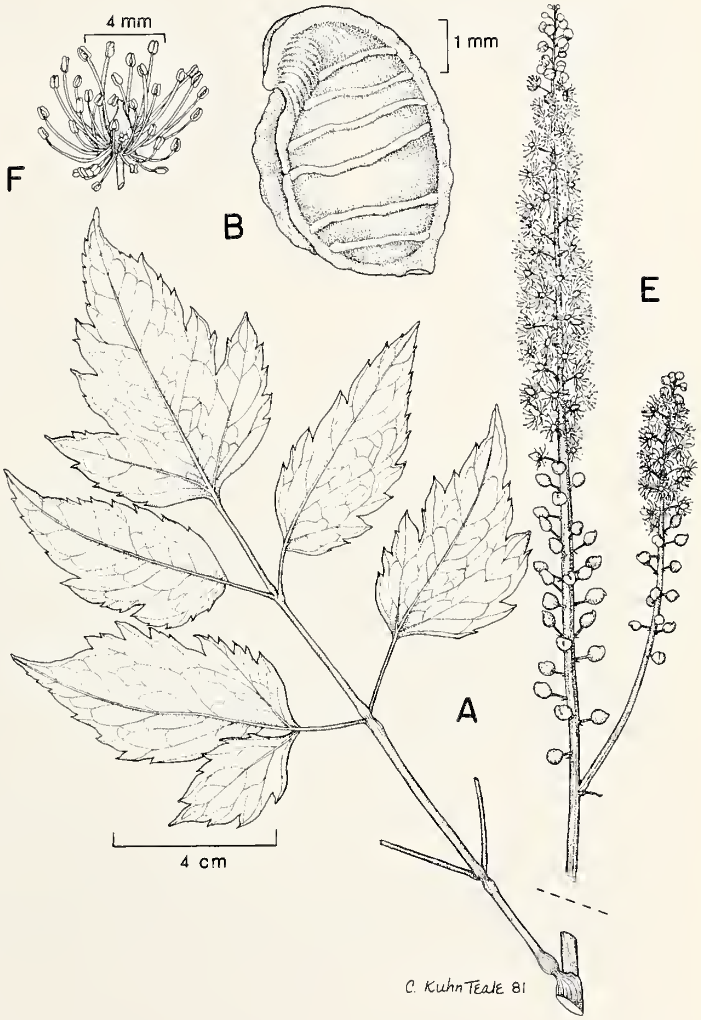
Habitats: Moist to dry woodlands, thickets

Habit: Large, perennial herbs

Flowering: June—September

Fruiting: July—December

General Distribution: Southern New England to s. Ontario, south to Georgia and west to Missouri, primarily Appalachian (escaping cultivation elsewhere)



Description: Plants with **bisexual** flowers; **stigma** 1 per ovary, broad, textured, knob-like or merely blunt; **style** 1 per ovary, thick, often recurved, ca 1 mm long; **ovary** 1 (rarely 2—3), not stalked, oval, ca 3 mm long, with several **ovules**, becoming a smooth to prominently ribbed, brownish, tough-walled **follicle** 6—9 mm long, 3—6 mm wide, dehiscent at the apex and along the adaxial suture, yielding several rough-sided **seeds**; **stamens** 20—70, showy, slender; **filaments** creamy, 6—9 mm long; **anthers** golden, ca 0.5 mm long; **staminodia** 4—7, pale, linear, bifid at tips, 3—4 mm long; **perianth** of 4—5 unfused, cup-like lobes, ca 3 mm long, 2 mm wide, which are greenish becoming cream-colored, and are shed at anthesis; **peduncles** 3—6 mm long and densely villous, as is the **axis** of the inflorescence; **bracts** 2—3 mm long, sparsely villous, lanceolate, 1 subtending each pedicel and inflorescence branch; **inflorescence** a compound raceme up to 9 dm in height, with upwardly-arching, lateral branches 1—4 dm tall; **leaves** pinnately, biternately or triternately compound, 10—45 cm long; **leaflets** strongly serrate-apiculate or doubly serrate, irregularly cut and lobed, 2—14 cm long, 1—9 cm wide, puberulent along the veins, especially when young; **petioles** stout, 3—10 cm long, the central **rachis** of the leaf puberulent to sparsely villous; **petiolules** often villous, 0—3 cm long; **stem** ribbed, glabrous to sparsely villous below the inflorescence, up to 2.6 meters tall, from a tough, gnarled **rhizome** and fibrous **root** system. (2n = 16)

Infraspecific Variation: There is considerable variation in leaflet shape and laceration; this has prompted use of such names as var. *cordifolia* (Pursh) Gray and forma *dissecta* (Gray) Fern.

Importance: The plants are occasionally cultivated and are known to escape in New England north of their natural range. The dried roots and rhizome have been extracted for use in folk medicine, but many of the supposed uses are contrary to the actual effects of the decoction. It is listed as an alterative, sedative and emmenogogue. It depresses vasomotor activity and stimulates uterine contraction. Due to hypoglycemia-inducing properties of certain alkaloids, the plant has joined a long list of potential antidiabetics. Overdoses produce headache, tremors, convulsion and vertigo.

6. ACTAEA

Common Names: Baneberry, Necklaceweed, Cohosh

Authority: Linnaeus, Species Pl., p. 504, 1753

This is a genus of about 5 species in boreal Eurasia and North America. Two species and their hybrids are native to New York State. They are poisonous (especially the berries and roots).

Description: Plants with **bisexual** flowers; **stigma** bilobed, sessile; **style absent; ovary** 1, with many **ovules,** becoming a fleshy, many-seeded **berry; stamens** numerous; **petals** small, narrowly spatulate; **sepals** 3—5, early deciduous; **pedicels** gradually shorter toward the inflorescence tip; **inflorescences** terminal and axillary racemes; **leaves** compound, pinnately and ternately; **leaflets** sharply toothed and often lobed; **stipules** sheath the lower stem; **stem** erect from a tough perennial **caudex** and **rootstock.**

KEY TO SPECIES*

1. Fruiting pedicels thick, 1—2.5 mm in diameter; fruit usually white; undersides of the leaflets glabrous, except for a few minute hairs on the veins .... 1. *Actaea pachypoda* (p.)
1. Fruiting pedicels slender, 0.3—0.7 mm in diameter; fruit usually red; leaflets puberulent on the undersides .... 2. *Actaea spicata* (p.)

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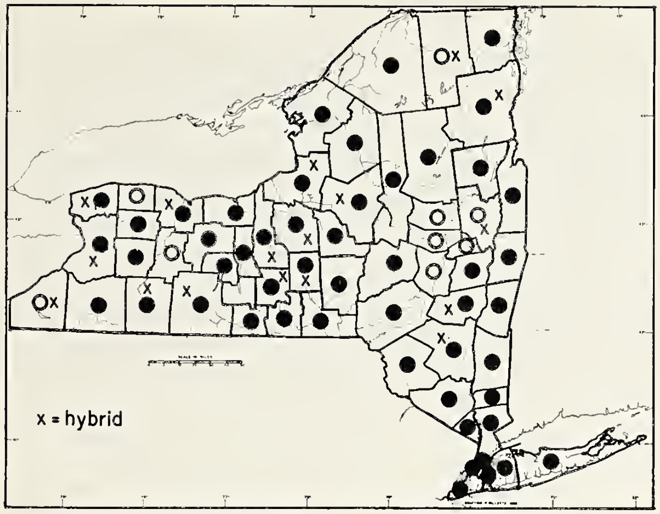
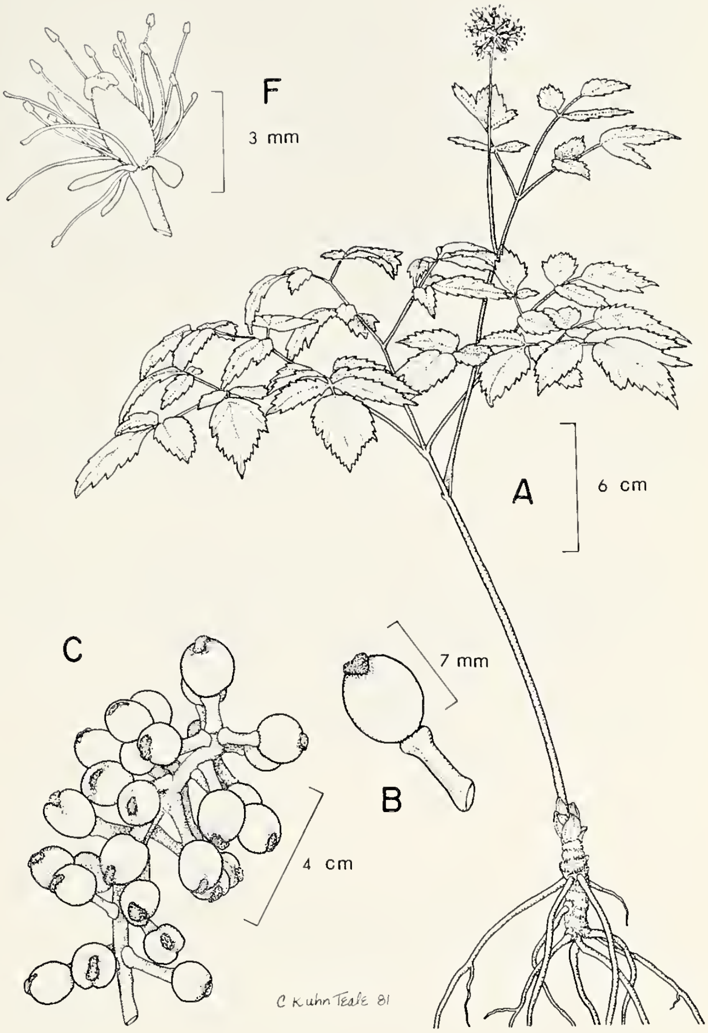
*Note: Plants showing combinations of the characters used in this key are known. See the sections on Infraspecific Variation and Hybridization for discussion.





1. *Actaea pachypoda* Ell.

Common Names: White Baneberry, White Cohosh, Doll's-eyes

Type Description: Elliott, Sketch. Bot. S. C. & Ga., vol. 2, p. 15, 1827

Synonyms: *Actaea spicata* var. *alba* L., *A. alba* (L.) Mill., *sensu* American authors, *A. americana* Pursh var. *alba* Pursh, *A. brachypetala* DC. var. *alba* DC., "*A. brachypoda*" mistakenly ascribed to Elliott by Rydberg.

Origin: Ancient Arctotertiary Forest

Habitats: Moist to dry, rich woods thickets and borders

Habit: Large, erect, perennial herbs

Flowering: May—June

Fruiting: July—October

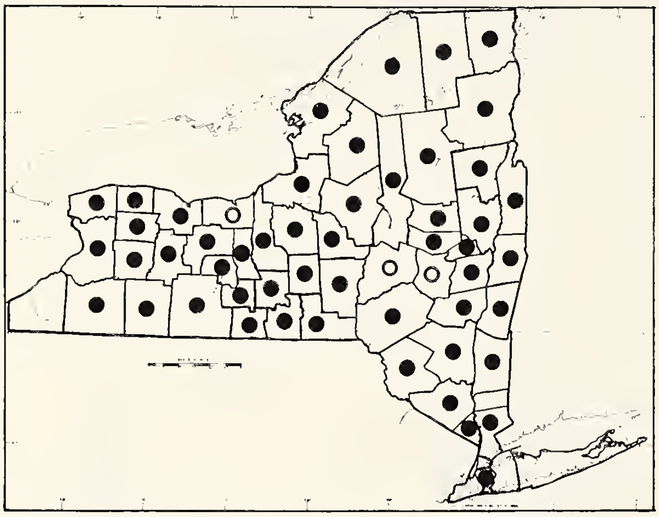
General Distribution: Nova Scotia to Manitoba, south to Louisiana, west to Oklahoma

Description: Plants with **bisexual** flowers: **stigma** 1, of 2 lip-like lobes, dark, rough in texture, 1—1.5 mm in diameter, as wide or wider than the young ovary, persistent, becoming enlarged and purple in fruit; **style absent; ovary** 1, keg-shaped, 2—3 mm long, 1 mm wide, with several **ovules**, becoming a several-seeded, globose **berry** in fruit; **seeds** brown, rough, wedge-shaped, ca 1.5 mm long; **berry** shiny, fleshy, white to ivory, often suffused with purple near the persistent stigma, 5—9 mm long, 4—7 mm wide; **stamens** 15—25; **filaments** broader near the tips, 4—5 mm long; **anthers** 0.5 mm long; **perianth** of 2 series or sepals absent; **petals** 4—10 grading from 3-veined, narrowly spatulate structures to single-veined, bifid-tipped, staminode-like lobes, cream-colored and 2—4 mm long; **sepals** (when present) dropping very early, whitish-green, ca 3 mm long and broad, enclosing the bud; **pedicels** thick, somewhat fleshy, minutely villous, 2—12 mm long in flower, elongating, up to 2.5 cm in fruit, becoming thicker 1—2 (4) mm thick, swollen at both ends, greenish-pink to red, often projecting at 80—90° angles from the infrutescence axis, each with 1—2 minute; sharp-pointed **bracts** at the base; **inflorescence** a dense raceme (in flower) 2—6 cm long, becoming more open as it grows, reaching lengths of (4) 7—17 cm in fruit; **axis** densely villous; **peduncle** less villous, a continuation of the stem, variable in length, depending on the proximity of leaves; **"bract"** sometimes present, consisting of a single leaflet between the inflorescence and leaves; **leaves** bipinnately to bi- or triternately compound, 1—5 (6) dm long; **leaflets** 3—many, irregularly toothed and lobed, with acute tips and attenuate to truncate or cordate bases, 1.5—15 cm long, 1—9 cm broad, glabrous or minutely pubescent along lower veins; **petioles** 2—20 cm long; **stipules** scarious, sheathing at the plant base; **stem** 4—12 (18) dm tall, from a tough, perennial **caudex** ca 1 cm in diameter, up to 10 cm long, with fleshy lateral **roots.** (2n = 16)

Infraspecific Variation and Hybridization: Red and pink-berried plants of *A. pachypoda* are known. Some of these have more pubescent leaves and are possible hybrids with *A. spicata* ssp. *rubra*. Such plants have been called *A. pachypoda* forma *rubra* (Killip) Fern.

Importance: All parts of the plants are poisonous, due to the presence of certain glycosides and essential oils. The ingestion of berries or roots is most common, resulting in stimulation possibly ending in circulatory failure, cramps, headache, dizziness and vomiting.

Note: The earliest description of white-berried plants reached Linnaeus from Cornut who stated that plants had white or red berries. Linnaeus chose to describe an American variety of European *A. spicata* with white berries only; he based his description on Cornut's illustration, which could only represent *A. spicata* or, at best, ssp. *rubra*, since the infructescence is dense, with filiform, ascending pedicels. Fur further discussion see Fernald (1940) and Gleason (1944).



2. *Actaea spicata* L. ssp. *rubra* (Ait.) Hult.

Common Names: Red Baneberry, Snakeberry, Black Cohosh

Type Description: Linnaeus, Species Pl., p. 504, 1753

Synonyms: *Actaea rubra* (Ait.) Willd., *A. spicata* var. *rubra* Ait., *A. arguta* Nutt., *A. neglecta* Gillm. ex Lloyd; *A. alba sensu* Rydb. not Mill. is the more western, white-berried form, *A. rubra* f. *neglecta* (Gillm.) Rob.

Origin: Ancient, Arctotertiary Forest

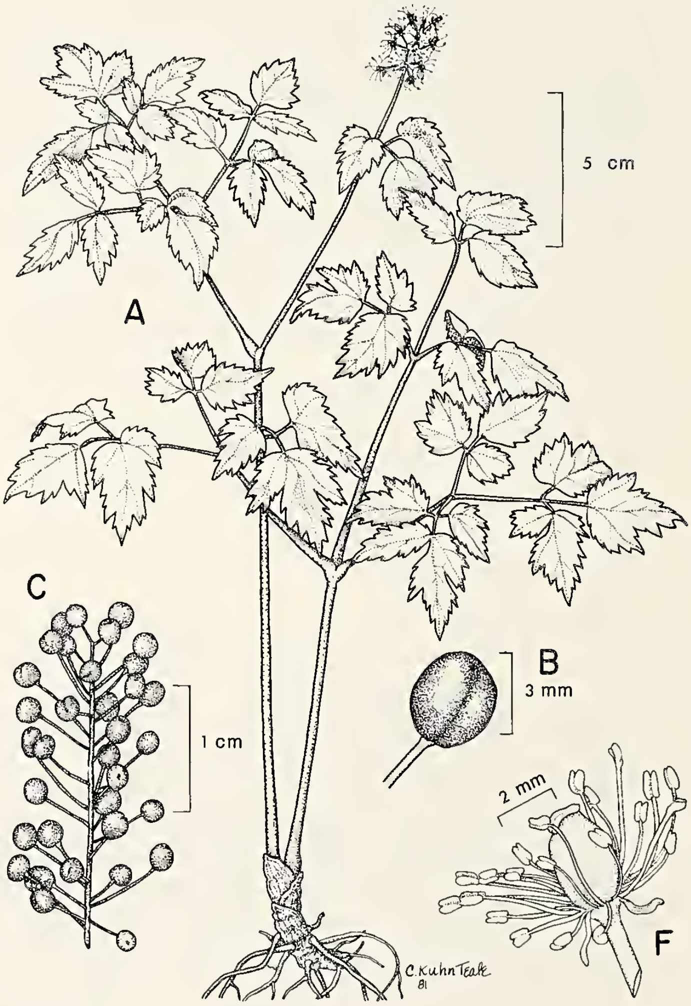
Habitats: Moist woods, thickets, streambanks, thickets

Habit: Large, erect or ascending, perennial herbs

Flowering: May—July

Fruiting: August—November

General Distribution: Southern Labrador to Alaska, south to Ohio, Indiana, Arizona, California



Description: Plants with **bisexual** flowers; **stigma** 1, of 2 lip-like lobes, dark rough in texture, 0.7—1.5 mm in diameter, usually narrower than the young ovary, persistent, but not enlarging or conspicuous in fruit; **style absent**; **ovary** 1, keg-shaped, 2—4 mm long, 1.5—2 mm wide, with several **ovules**, becoming a several-seeded, globose to ellipsoid **berry** in fruit; **berry** fleshy, bright to dull red (rarely white), 7—12 mm in diameter; **seeds** rough, brown, wedge-shaped, semicircular, ca 3 mm long; **stamens** 15—25; **filaments** slender, 3—9 mm long; **anthers** 0.5 mm long; **perianth** of 2 series; **petals** (4) 5—9 (10) or rarely lacking, 2—4 mm long, spatulate, 3 (1) veined, green and creamy white; **sepals** 3 (-5) cupped, ca 2 mm long, creamy-white to greenish or purple tinged, early deciduous; **pedicels** slender, densely pilose, 3—10 mm long in flower, becoming reddish-scabrescent, 10—25 (30) mm long, 0.3—0.7 mm wide in fruit, slightly ascending or at right angles to the axis; **bracts** minute, pointed, 1 at the base of most pedicels; **inflorescence** a globose to elongate raceme, 2—5 cm long, growing to 5—7 cm long in fruit; **peduncle** densely villous, less so below, where it is merely an extension of the stem, quite variable in length depending on proximity of a leaf; **leaves** bipinnately to bi- or tri-ternately compound (0.5) 2—5 dm long; **leaflets** 3—many, irregularly toothed and lobed, with acute to acuminate tips and attenuate to truncate bases, 1—13 cm long, 0.5—8 cm broad, minutely puberulent to villous beneath; **petioles** 2—24 cm long; **stipules** sheathing at the plant base; stem 5—17 dm tall, often branched, arising from a tough, perennial **caudex**, ca 1 cm in diameter, 6—12 cm long, with fleshy, tough, lateral **roots.** (2n = 16)

Infraspecific Variation and Hybridization: This native subspecies is part of a circumpolar complex of taxa which vary mainly in fruit color and leaf dissection (Hultén, 1971). White-fruited plants of the species are known from New York State, and are relatively common in western states. When these show more prominent, purplish stigmas and little pubescence, they are suspected hybrids with *A. pachypoda*. Sterility of fruit in a number of specimens also lends credence to the theory that they are of hybrid origin. *Actaea pachypoda* forma *rubra* varies in pedicel thickness and fruit color (red to pink) providing the clinal link between the species. Rarely the leaves and inflorescence are borne on separate stalks.

Importance: As in White Baneberry, all parts of the plant are poisonous, especially the caudex, roots and berries. We know of at least one case where an inexperienced collector mistook the plants for Ginseng. Red Baneberry is not a commonly cultivated plant, but can be a nice addition to a garden, due to its handsome foliage and late summer berries.

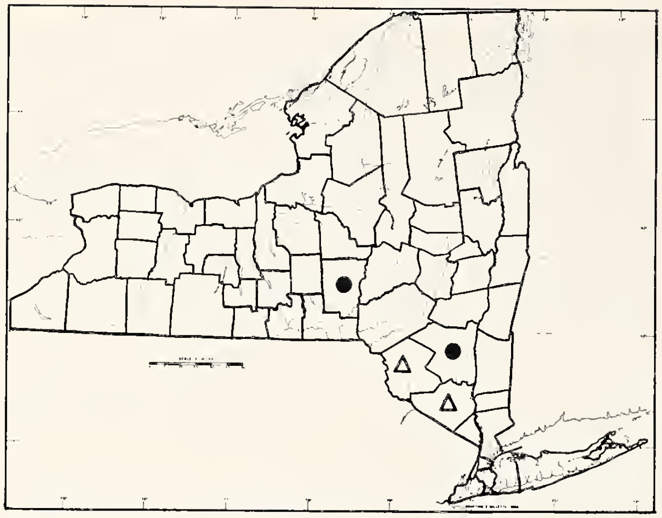
7. ACONITUM

Common Names: Monk's-hood, Aconite, Wolf's-bane

Aurthority: Linnaeus, Species Pl., p. 532, 1753

A large, boreal genus with 50–100 species in Eurasia and North America. Several species occur in Alaska, California and the Rocky Mountains, notably *A. columbianum* and *A. delphinifolium.* The three species native to the north-central and eastern U. S. are somewhat local to rare, and probably represent relicts of Arctotertiary associations. *Aconitum uncinatum* and *A. reclinatum* are southern Appalachian elements, while New York State's only species, *A. noveboracense*, is an extreme rarity, known only from a few sites in New York, Wisconsin, Iowa and Ohio. Plants of this genus are grown as ornamentals and are a source of drugs.

Description: Plants with **bisexual** flowers; **stigma** 1 per ovary, minute; **style** short, pointed; **ovaries** 3–5, free, becoming several-seeded **follicles; seeds** angled and winged, often with minute scales; **stamens** numerous, the **filaments** expanded near the bases; **petals** 2–5, the upper ones concealed in the "helmet" of the calyx; each **upper petal** bearing a coiled nectary or spur at its summit and a lateral, expanded lamina, clawed below; **lower petals** usually vestigial; **sepals** 5, petaloid, the upper one arched over the others, resembling a **helmet** or hood; **lateral sepals** long-oval to reniform; **pedicels** glabrous or pubescent; **inflorescences** of racemes, clusters or flowers borne singly at branch tips; **leaves** palmately lobed and variously cut and toothed, with long to short **petioles** (nearly sessile near the flowers); **stems** slender to thick and tough, often branched, erect or reclining, some species even twining on other plants; arising from root-stem transition **tubers** which are pale and fleshy, perennating by producing a budding new **tuber** (stalked or unstalked) from the disintegrating old one each year.



1. *Aconitum noveboracense* Gray ex. Cov.

Common Names: Northern Monk's-hood, New York Monk's-hood, Aconite

Type Description: Gray in Coville, Bull. Torrey Club 13, p. 190, 1886

Synonym: *Aconitum uncinatum* L. ssp. *noveboracense* (Gray) Hardin

Origin: Northwestern North America or pre-Pleistocene central Canada

Habitats: Streamside crevices, damp, cold, mossy talus, moist cliff bases and ravines in rich woods or partial clearings in seeps

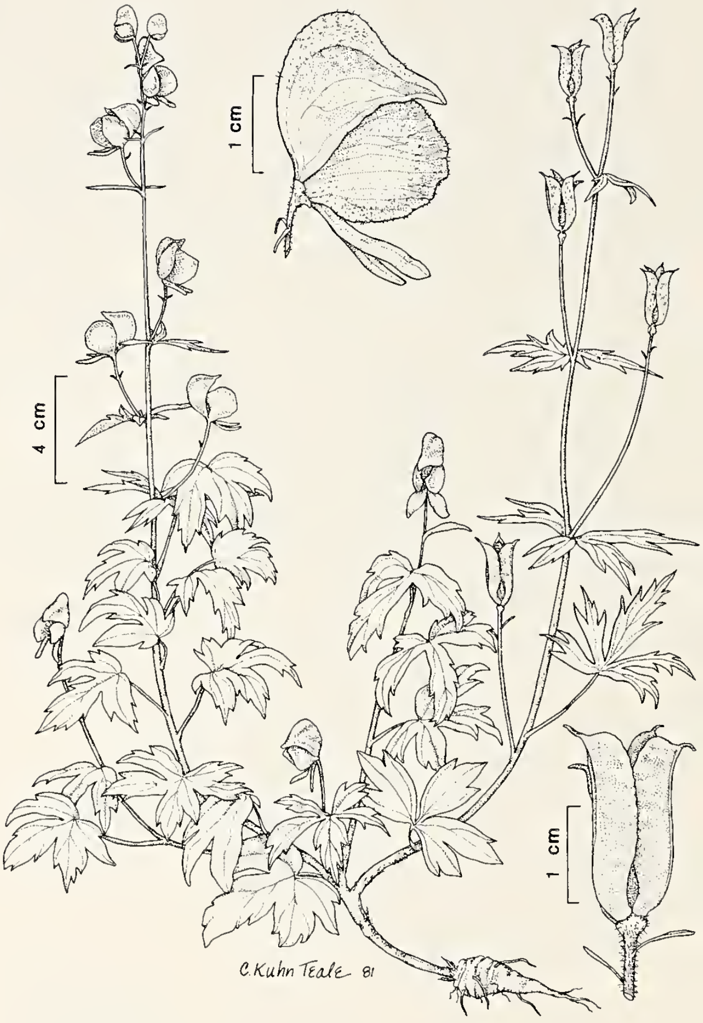
Habit: Branched or simple, erect (or ascending) herbaceous perennials (usually erect but may be prostrated by stream flooding)

Flowering: Mid—July to October

Fruiting: August—November

General Distribution: A few scattered colonies in New York State, Wisconsin, Ohio and Iowa

Rarity Status: Protected under the federal Endangered Species Act of 1973; listed threatened in 1978; protected under New York State law



Description: Plants with **bisexual**, protandrous flowers; **stigma** 1 per ovary, minute; **style** 1 per ovary, short, pointed; **ovaries** 3–5, fusiform, each becoming a several-seeded **follicle**; follicles 3–5, narrowly cylindric, ca 2 cm long, 5 mm wide with persistent styles, tan to dark brown, veiny, dehiscing along the upper (adaxial) side; **seeds** 2–3 mm in diameter, strongly angled and veined, straw-colored to dark brown with chaffy scales on some surfaces and a longitudinal wing; **stamens** numerous, 5–7 mm long; **anther** sacs yellowish, 0.4–0.6 mm long; **filaments** slender, expanded at their bases; **petals** 2–5, the upper 2 well developed, pinkish-purple tinged, concealed by the upper sepal (hood); **upper petal segment** 6 by 3 mm, tubular, with a recurved, glandular tip and a flared lip below; lower portion narrowed to a caniculate **claw** ca 7 mm long; **lower** three **petals** (when present) vestigial, minute; **sepals** petaloid, intensely deep purple to lavender-blue, finely pubescent in patches, especially within; **lower** 2 **sepals** oblanceolate, ca 11–15 mm long, 3–6 mm wide; **lateral** 2 **sepals** orbicular, 12–13 mm long, 9–18 mm wide; the **hood,** a large upper sepal, galeate, hemispheric to slightly conically extended upward, ca 14–21 mm high, 9–15 mm deep, with a blunt to obtuse apex; **inflorescence** type dependent on age and vigor of the plant, varying from terminal panicles to racemes, to double or single flowers at the lower branch tips; 2–3 flushes of flowers may occur in a season, leaving ripe fruit at the plant summit and flowers near the base by October; **pedicels** 1–3 cm long, densely white-pubescent; **peduncles** (when present) less pubescent than pedicels; **leaves** palmatifid, alternate, dark green, sometimes leathery, orbicular in outline, 2–9 cm broad, with or without a fine pubescence, **lobes** (3) 5–7, cuneate and ternate or deeply cut, with acuminate to acute teeth; **petioles** 0.1–8.5 cm long, reduced upward on the stem; **stipules absent; stems** terete, simple or branched, erect or ascending up to 1.5 m tall, from a short, whitish, tuberous **rootstock** with 1-several closely associated daughter tubers (2n =16)

Infraspecific Variation: Intensity of the typically deep purple flowers varies from year to year as do the whitish areas on the lateral sepals. In strong light flowers often show an irridescent rose glow suggesting possible ultra-violet transmition. Some individuals have dark purple to black stems, and these have been seen to be visited by hummingbirds, perhaps preferentially. Plants may develop minute, whitish, apically scaly bulblets in the leaf axils. Browsed plants often have less dissected leaves—commonly ternate. Helmets vary in shape.

Taxonomic Note: We are considering this to be a full species in this treatment; however, it is perhaps better considered a subspecies or variety of *A. columbianum* of the west. No such combination had been made at the time of this publication. Hardin (1964) reduced *A. noveboracense* to a subspecies of *A. uncinatum*, a logical choice within the context of the eastern United States. The tuber type in *A. noveboracense* is sub-sessile, however, and pubescence, erectness and helmet types appear to put its affinities with the *A. columbianum* complex.

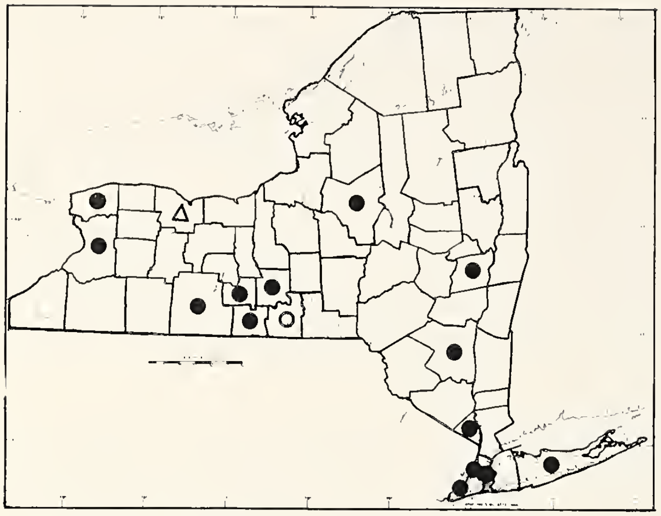
Importance: Closely related species are known to be very poisonous. *Aconitum* species contain toxic alkaloids, and are the source of the drug Aconite and the alkaloid Aconitine. Extracts are known to be highly sedative, to slow heart activity, and, in all but the most minute quantities, to paralyze the nervous and circulatory systems. Applied externally they are used (mostly in Europe) for complaints of neuralgia and rheumatism. They can kill, however, by entering the bloodstream through breaks in the skin. Pseudo-aconitine, found in some species, is one of the most deadly poisons known. Both humans and livestock may be killed by ingesting small amounts of plant materials. The planting of Aconites in gardens or near vegetables has led to deaths when the tubers were mistaken for horseradish. *Aconitum noveboracense* is frequently browsed by deer with unknown effects.

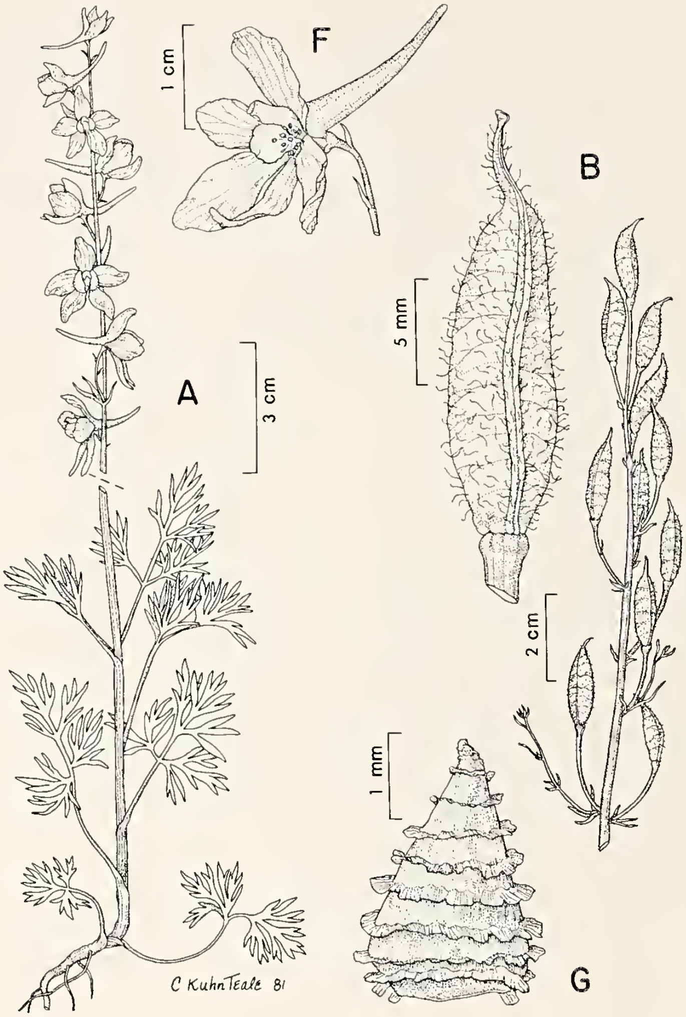
8. CONSOLIDA

Commong Names: Larkspur, Delphinium

Authority: (DC.) S. F. Gray, Nat. Arr. Brit. Pl., vol. 2, p. 711, 1821

A genus of about 50 species of annual herbs, native to Eurasia (excluding the true Delphiniums). They are sometimes included in the genus *Delphinium*, but are quite distinctive in having a single petal and follicle. A number of native *Delphinium* species occur to the west and south of New York State, but none have been reliably reported to occur here. Our two species of *Consolida* are garden escapes. *Consolida regalis* S. F. Gray is not treated here because of the rarity of its escape and its lack of persistence.





1. *Consolida ambigua* (L.) Ball & Heyw.

Common Name: Rocket Larkspur

Type Description: Linnaeus, Species Pl., ed. II, p. 749, 1763

Synonyms: *Consolida ajacis* of authors, not (L.) Shur, *Delphinium ajacis* of authors, not L., *Delphinium ambiguum* L., *Delphinium consolida* in Torrey Flora, not L.

Origin: Mediterrainian region

Habitats: Roadsides, grassy fields and disturbed ground as an escape

Habit: Erect, branching annuals

Flowering: May—August

Fruiting: June—October

General Distribution: Escaping from gardens in boreal North America and Asia (as well as in Europe where it is also native)

Description: Plants with **bisexual** flowers; **stigma** 1, capitate, **style** 1, slender, persistent; **ovary** 1, fusiform, densely villous, ca 4 mm long with several ovules, becoming a several-seeded **follicle;** follicle 1, 10–27 mm long, 4–7 mm wide, cylindric-fusiform, beaked, villous; **seeds** 2 mm by 1 mm, brown, twisted and covered with transparent scales; **stamens** (5) 9–15, densely clustered about the ovary; **filaments** 4–5 mm long, the lower half of each expanded-caniculate, the upper half filiform; **anthers** golden, ca 1 mm long; **petal** 1, trapezoidal in front view, mitten-shaped in lateral view, with two narrow, upper lobes and two broader lateral ones, 8–11 mm long, colored like sepals but paler; **sepals** 5, petaloid, purple, blue or pink, tinged with white (or pure white), 5–10 mm long and broad, except for the uppermost, which forms a **spur** 7–16 mm long; spur long-attenuate, nectariferous; **pedicels** ribbed, villous, 2–12 mm long (up to 20 mm in fruit), often with tiny, villous **bracteoles; bracts** linear, single or branched, much like the leaves, villous; **inflorescence** a dense to open raceme 5–20 (30) cm long (see discussion of abnormalities below); **leaves** villous to almost glabrous, alternate, palmately divided and subdivided into many linear segments which are 1–3 cm long, 0.5–3.1 mm wide; total leaf width 3–7 cm, length 3–9 cm; **petioles** villous, caniculate, 0.1–8.0 cm long or leaf sessile; **stipules** absent or indistinguishable from leaves; **stems** terete, ribbed, sparsely to densely villous, often branched, up to 1.5 m tall from an annual **taproot.** (2n = 16)

Infraspecific Variation and Teratology: Flower color and size are variable, and large-flowered, color variants are much sought after in the seed trade. Teratological inflorescences are known in which stamens are borne on dense, leafy shoots which may arise from the pedicel bases in late season after fruiting.

Importance: These plants are much-cultivated and escape and persist in disturbed situations. Like *Delphinium* they contain the poisonous alkaloids: Ajacine, Delphinine, Delphineidine; these cause nervous system damage, depression, stomach upset and in quantity may result in death. This species is also listed as a cause of dermatitis in some people.

9. ANEMONE

Common Names: Windflower, Anemone

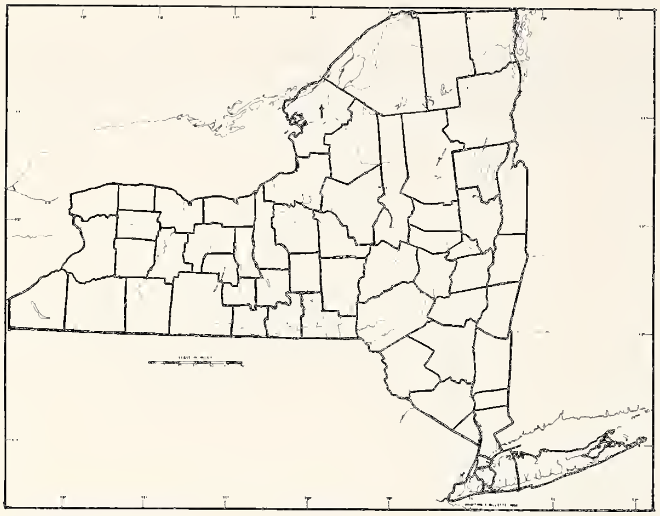
Authority: Linnaeus, Species Pl., p. 538, 1753

A genus with over 150 described species worldwide, mostly in cooler temperate and arctic regions. The number of species is probably fewer than 100, since races of many of them are given species rank in various geographic regions, and hybrids also confuse the taxonomic situation. The plants are often quite variable within populations, and sometimes from branch to branch. *Anemone* species are widely cultivated as garden ornamentals, the Pasque Flowers being particularly desirable (these are probably best treated as the segregate genus, *Pulsatilla*). A number of *Anemone* species are used medicinally for their alkaloids and acrid oils.

Description: Plants with **bisexual** flowers; **stigma** 1 per ovary, linear to punctate; **style** 1 per ovary, short to filiform, often pubescent; **ovaries** numerous on a hemishpheric to cylindric **receptacle** which may elongate in fruit; **ovaries** oval, fusiform or lenticular, with 1 (2) **ovules**, each producing a follicle-like **achene** with a single pendulous **seed; achenes** often silky or woolly, lenticular or fusiform, carried away from the ripe receptacle by the wind or fur of animals which may catch in the **persistent styles; stamens** numerous; **perianth** of a single series of free, petaloid parts (**sepals**), which are (4) 5–6 (15) in number, oval to elliptic-lanceolate or even linear, white, greenish or with weak to strong infusions of blue, yellow, purple, red or orange; **peduncles** usually elongate, slender, 1–several, often arising from an **upper node** ringed with 3 or more petioled or sessile **involucral leaves** ("bracts"); **involucels** also may be present above; **leaves** palmately divided (pinnately), variously cut, toothed and lobed; **basal leaves** and often involucre **petioled; stems** erect or spreading from a perennial **caudex** and/or **rhizome** with a tough, fibrous **root** system.

KEY TO SPECIES OF ANEMONE

1. Ripe achenes not woolly, partially glabrous or with whitish, hispid hairs; fruiting heads capitate to spheroid ....(4)
1. Ripe achenes densely matted with curly wool; fruiting heads ovoid-oblong or cylindric ....(2)
    2. Leaves deeply cleft to near the bases into many, narrowly lanceolate, 1 to 2-branched lobes; plants with 1 (rarely 2) flowers per stem ....1. *A. multifida* (p.)
    2. Leaves variously cut and toothed, but with major lobes expanded toward tips, not lanceolate; stem usually with 2–many flowers ....(3)
3. Mature fruiting heads cylindric, mostly 2–5 times as long as broad; styles crimson (drying red-brown), encroached upon by dense, woolly masses from the fruit coat; peduncles arising from a common point, 3–8 involucral leaves at the node, terminating the leafy portion of the stem ....2. *A. cylindrica* (p.)
3. Mature fruiting heads ovoid, 1–1.5 (2) times as long as broad; styles pale brown (stigmas red-tipped), villous to glabrescent, (styles) not dense-woolly; peduncles with 3 involucral leaves at their base, often with involucels above ....3. *A. virginiana* (p.)
    4. Involucral leaves strongly petioled; achenes uniformly hispid; plants slender, somewhat delicate ....4. *A. quinquifolia* (p.)
    4. Involucral leaves sessile or very short petioled; achenes strongly hispid near the convex centers, glabrate near the margins; plants coarse ....5. *A. canadensis* (p.)



1. *Anemone multifida* Poir. ex Lam.

Common Name: Cut-leaved Anemone

Type Description: Poiret in Lamarck, Encyc. Meth. Bot. Suppl. 1: 364, 1810

Synonyms: (New York populations) *Anemone hudsoniana* (DC.) Richards., *A. multifida* var. *hudsoniana* DC., *A. multifida* var. *uniflora* DC., *A. sanguinea* Pursh

Origin: Northwestern North America?

Habitats: (New York) Limestone outcrops and flatrock, along river bluffs

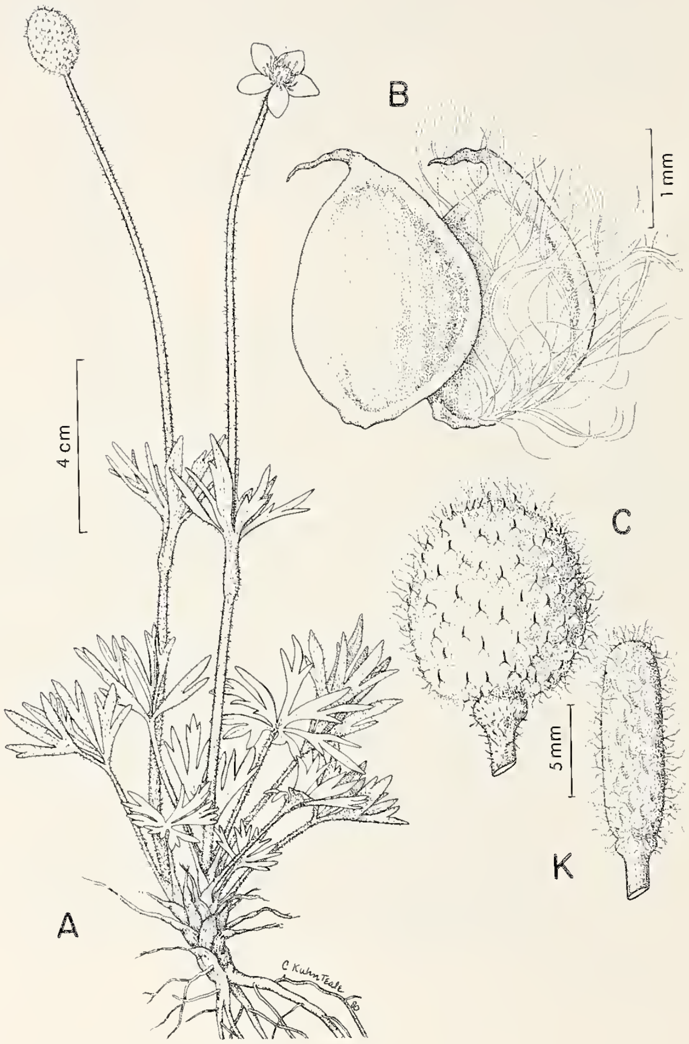
Habit: Perennial herbs, somewhat tufted, from a caudex

Flowering: May—June

Fruiting: June—August

General Distribution: Alaska to the central Rocky Mountains, northern Great Lakes to Nova Scotia with southern outliers in California, New Mexico, New York and Vermont (also South America)

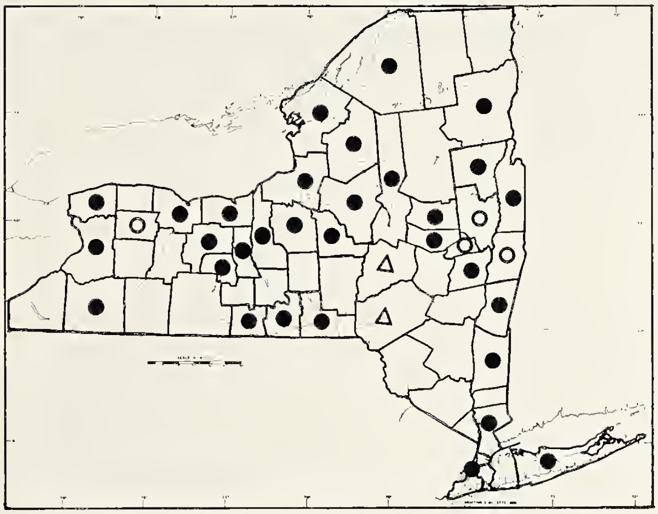
Note: The following description is for New York State populations only. Details of the broad range of variability in this species complex are deleted.

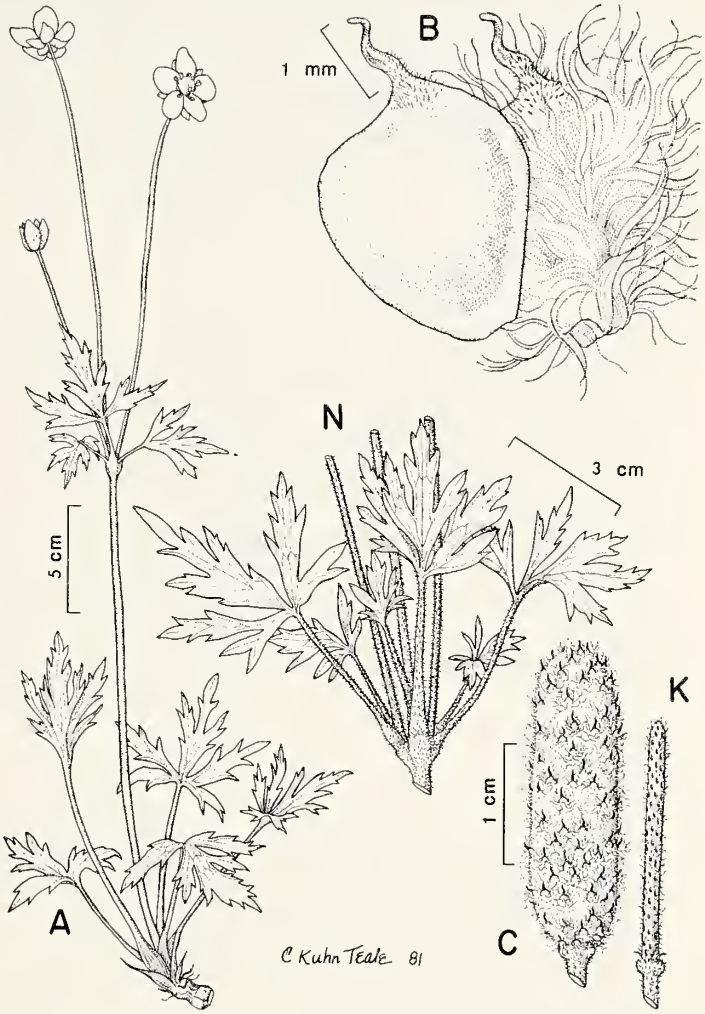


Rarity Status: Because of its rarity in the eastern U. S., this species has been proposed for protection in New York State. It is perhaps extirpated here, but might still be found in Jefferson County.

Description: Plants with **bisexual** flowers; **stigma** small, 1 per ovary, punctate; **style** 1 per ovary, cylindric, glabrous to near the base; **ovaries** many, fusiform, ca 2 mm long, extremely pubescent with a silvery tomentum, becoming woolly, fusiform **achenes**, 2 mm long, 1 mm wide; **seeds** 1 per fruit, pendulous; **receptacle** obconic, elongating to produce an ovoid **fruiting head**, 7–12 mm long, 5–9 mm wide; **stamens** about 15–20; **anthers** very small, golden; **filaments** upcurved, ca 2 mm long; **perianth** 5 parted, petaloid; **sepals** (3) 6–9 mm long, 3–5 mm wide, oval, strongly red-tinged to greenish-white; **peduncles** 3.5–16 cm long, sparsely to densely villous; **flowers** borne on peduncles, singly or as a pair from the upper node of each branch; **peduncles** subtended by 3 **involucral leaves** (bracts); involucral leaves simply ternate, petioled (not sessile as reported), consisting of deeply cut blades; **leaf lobes** of 1–3 narrowly-lanceolate segments, 1–3 mm wide, 2–16 mm long; **leaf blades** fan-shaped, 6–48 (55) mm wide, 5–36 mm long, sparsely villous to glabrous; **basal leaves** like the involucral ones, but often smaller and less pubescent; **petioles** 4–8 mm long (involucral) and 0.6 –13.5 cm long (basal), somewhat sheathing at their bases, sparsely villous to hispid; **stems** slender, with a single node, villous-hispid; plants up to 40 cm tall, from a woody **caudex** 4–7 mm thick, with slender, fibrous **roots**. (2n = 32, 16?)

Infraspecific Variation: This species is extremely wide-ranging and variable. For an excellent discussion of the polyploid complex, see Boraiah and Heimburger (1964). Our plants are frequently referred to *A. hudsoniana* (2-flowered), but most specimens have a single flower, making them "var. *uniflora*." Although flower number seems at first to be a trivial character, it appears to delimit certain geographic and morphological subunits in this particular species. Red flower color is reported for New York populations, but specimens are old, and since no living populations are presently known, it cannot be checked.





2. ***Anemone cylindrica*** **Gray**

Common Names: Thimbleweed, Long-headed Anemone, Thimblehead Anemone

Type Description: A. Gray, Ann. Lyc. N. Y., 3: 221, 1836

Origin: Northern North America

Habitats: Dry, open areas, grassy slopes, prairies, ditches and roadsides, waste places

Habit: Erect or ascending, perennial herbs

Flowering: June—August

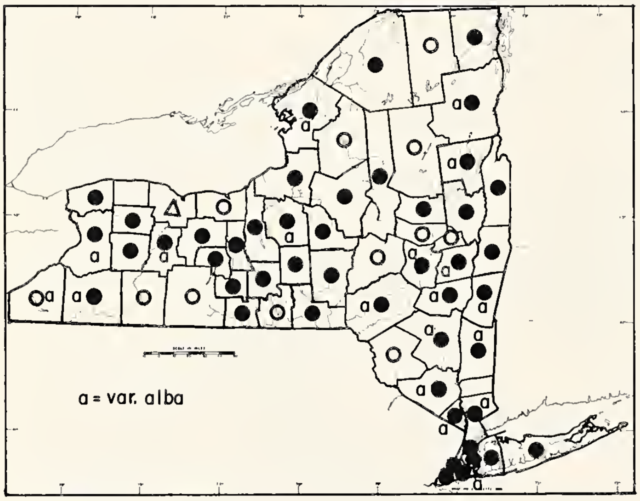
Fruiting: July—October

General Distribution: Maine across Canada to British Columbia, south to Arizona, Kansas, Ohio and New Jersey.

Description: Plants with **bisexual** flowers; **stigma** 1 per ovary, minute, on a narrowly cylindric, crimson **style;** style villous, 0.5–1.0 mm long, often reflexed or hooked at the tip, encroached upon by woolly hairs from the ovary; **ovaries** numerous, ca 0.5 mm long, lenticular with a single **ovule,** hispid to densely woolly, on an obconic **receptacle** which elongates in fruit; **achenes** 1.5–2.5 mm long, pinkish, covered with a woolly knap; **seed** pendulous within the achene, 1–1.5 mm long; **fruiting heads** densely cylindric, 1.5–4.7 (6) cm long, 0.5–1.3 (1.8) cm wide before dispersal, often bearing over 100 achenes, becoming a fluffy mass, leaving behind a narrow, conical receptacle; **stamens** about 30–40, 2–4 mm long; **anthers** ca 1 mm long, golden; **filaments** filiform; **perianth** 5-parted, petaloid; **sepals** free, 5–7 (9), oblong to oval, 4–9 (12) mm long, 3–5 (7) mm wide, with rounded or obtuse tips, greenish white, creamy or rarely red-tinged, densely woolly-villous on the abaxial sides, almost glabrous within; **peduncles** reddish, very densely sericeous and white near the flowers, 6–25 cm long, **lacking involucels; inflorescence** of 2–6 (9) long, single-flowered peduncles, borne from a common point at the **vegetative apex;** vegetative apex with 3–6 (11) involucral leaves and **involucels** all borne from the same node; **involucral leaves** 3 to 5-palmately lobed with shallowly to deeply cut and branched (sometimes toothed) lobes which are cuneate and relatively narrow at the bases (Geranium-like) 1.5–7.0 (10) cm broad and long, darker green above and sparsely sericious, pale below, densely sericious-silky; **basal leaves** like the involucral ones, but up to 12 cm in diameter, long-petioled; **petioles** reddish, sometimes grooved, sparsely to densely sericeous-woolly, 0.5–5.5 cm long in involucre, (5) 7–19 (24) cm long in basal leaves; **stem** reddish-brown (2) 4–9 (12) dm tall, from a single (rarely double) tough **caudex** ca 5 mm broad, with tough, fibrous **roots**. (2n = 16)

Infraspecific Variation: Putative hybrids between this species and *A. virginiana* are known, but not in sufficient numbers to suggest a clinal transition or warrent the two species being merged taxonomically, Obvious hybrids are rare, but have such unlikely combinations as broad-lobed leaves, involucels on the peduncles and narrowly cylindric fruiting heads. So-called *A. riparia* is of possible hybrid origin, and is discussed further under *A. virginiana*.

Importance: This species is sometimes a noxious weed, and is poisonous. Boiled extract was used by Indians in the treatment of wounds, utilizing the antiseptic properties of Anemonine.



3. *Anemone virginiana* L.

Common Names: Thimbleweed, Tall Anemone or Thimbleweed

Type Description: Linnaeus, Species Pl., p. 540, 1753

Synonyms: *Anemone riparia* Fern., *A. riparia* forma *rhodantha* Fern., *A. virginiana* var. *riparia* (Fern.) Boiv., *A. virginiana:* (forma *leucosepala* Fern., forma *rubrosepala* House and forma *inconspicua* Fern.), *A. cylindrica* var. *alba* Oakes

Origin: Eastern North America

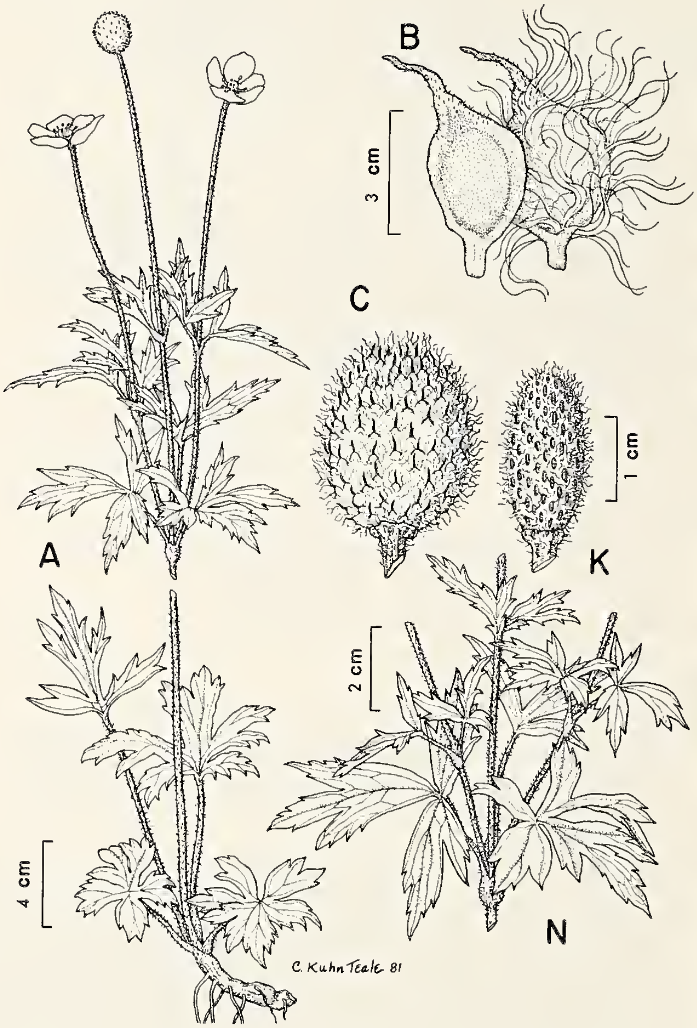
Habit: Erect to ascending, perennial herbs

Habitats: Dry to moist, open woods, clearings, roadsides and streambanks

Flowering: June—August

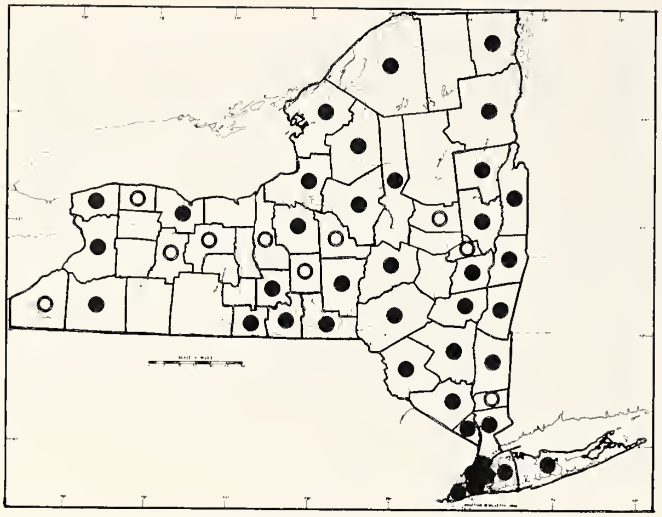
Fruiting: July—October

General Distribution: Newfoundland across Canada to British Columbia, south to Kansas, Arkansas and Georgia



Description: Plants with **bisexual** flowers; **stigma** 1 per ovary, minute, often reddish, on a tapered, greenish-tan **style**; style 1 per ovary, glabrous or with a few stiff, short hairs, ca 1.5 mm long, sometimes reflexed at the tip; **ovaries** numerous, ca 1.5 mm long, with soft, white hispidity (each containing a single **ovule**), borne on a swollen **receptacle** which elongates in fruit; **achenes** 1.5–2.2 mm long, lenticular, brownish-pink, covered with a silky to woolly knap, the short-haired to glabrous **beak** (style) projecting from the silk; **seed** pendulous within the achene, 1–1.5 mm long; **fruiting head** ovoid, (0.9) 1.5–3.2 cm long, (0.6) 0.9–2.8 (3.1) cm wide before dispersal, becoming a silky mass, leaving behind a short-cylindric receptacle; **stamens** about 30–40, 4–7 mm long; **filaments** filiform; **anthers** elongate, 0.7–1.7 mm long, golden; **perianth** 5-parted; petaloid; **sepals** free, usually 5 (6–9), oblong to elliptic-oval, 4–16 mm long, 3–12 mm wide, with rounded (to obtuse or acute) tips, white, creamy, greenish or rarely red- or rose-tinged, densely villous to woolly on the abaxial surfaces, sparsely pubescent to glabrous within; **peduncles** reddish-brown to green, very densely sericeous and white near the flowers, 5–21 cm long, less pubescent downward and often grooved or angled, sometimes with leaf-like **involucels** above the point of attachment; **inflorescences** of 2–5 (6) cm long, single-flowered peduncles, borne from a common point, this node usually bearing 3 **involucral leaves**; involucral leaves 3 to 5-palmately lobed with broadly rhombic-ovate segments, with mostly convex margins toward the base (cuneate in var. *alba*), 1.5–8.0 cm broad and long, sparsely to moderately hispid above, dark green, sparsely to moderately hispid below, paler green to pinkish; **basal leaves** like the involucral ones, but up to 18 cm in diameter, long-petioled; **petioles** somewhat villous, reddish to greenish-brown, 1.2–6.5 cm long in the involucre, 8–28 cm long in basal leaves; **stem** stout, greenish-brown, moderately to densely villous, (3) 5–8 (10) dm tall, from a tough **caudex**, 5–15 mm in diameter, with fibrous **roots**. (2n = 16)

Infraspecific Variation and Hybridization: This seldom-studied group of plants presents some interesting problems in variation. Almost undisputable hybrids between *A. virginiana* and *A. cylindrica* are known, which exhibit not only intermediacy but mixtures of the strong leaf characters of one species with the fruiting heads of the other. Though such plants are rare, they lend credence to the hypothesis that these species occasionally cross in nature. To confound this situation, there is *A. virginiana* var. *alba* Wood. Unlike other varieties or color forms (which can be largely discounted) this entity has a morphology, habitat and range of its own, and has been considered a full species, *A. riparia* Fern. The plants have somewhat larger flowers and smaller fruiting heads than *A. virginiana* var. *virginiana*, and the leaf shapes and head shapes tend toward *A. cylindrica*. The habitat is generally moister and often shadier than for either of the typical varieties of the two species. It is possible that this variety was derived through ancient hybridization of *A. virginiana* and *A. cylindrica*, and has now back-crossed to *A. virginiana* sufficiently to form a morphological bridge as well as an ecological cline. Variety *alba* has a much broader northern range than typical var. *virginiana*, and has apparently inherited the heterozygosity needed for postglacial invasion of cool, moist habitats—thus expanding the range of the species.



4. *Anemone quinquefolia* L.

Common Names: Wood Anemone, Snowdrops, Windflower

Type Description: Linnaeus, Species Pl., p. 541, 1753

Synonyms: *Anemone nemerosa* L. var. *quinquefolia* (L.) Pursh, *A. nemerosa* ssp. *americana* Ulbrich, *A. nemerosa* f. *quinquefolia* (L.) Britt., *A. pedata* Raf., *Anemonantha quinquefolia* (L.) Nieuwl., *Nemerosa quinquefolia* (L.) Nieuwl.

Origin: Ancient Arctotertiary Forest

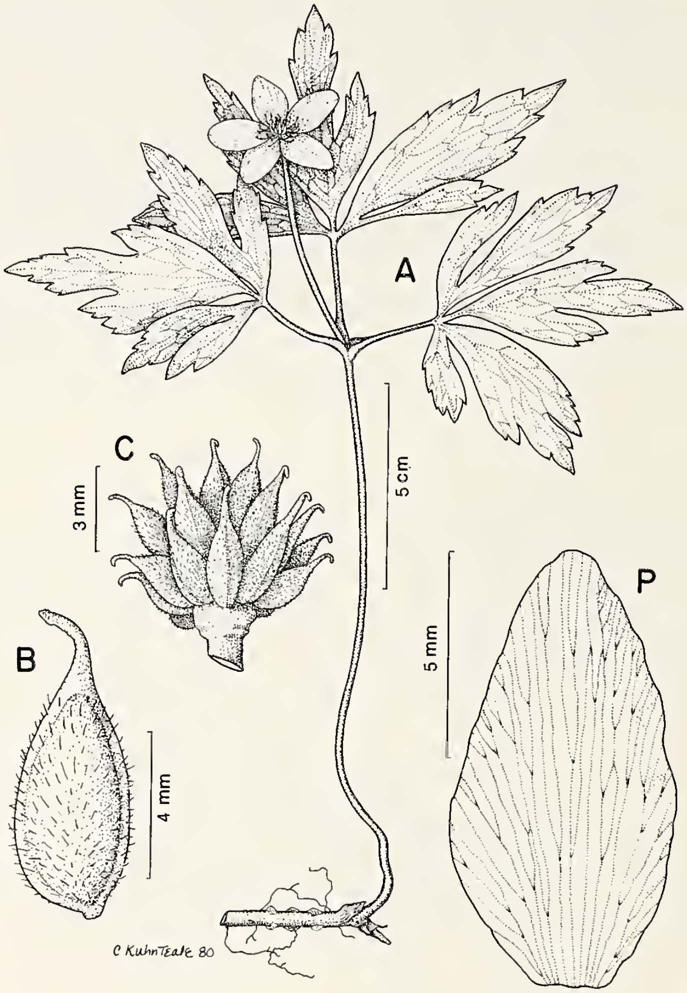
Habit: Erect to ascending, slender perennial herbs

Habitat: Moist, often rocky woods, thickets and clearings

Flowering: April—June

Fruiting: May—August

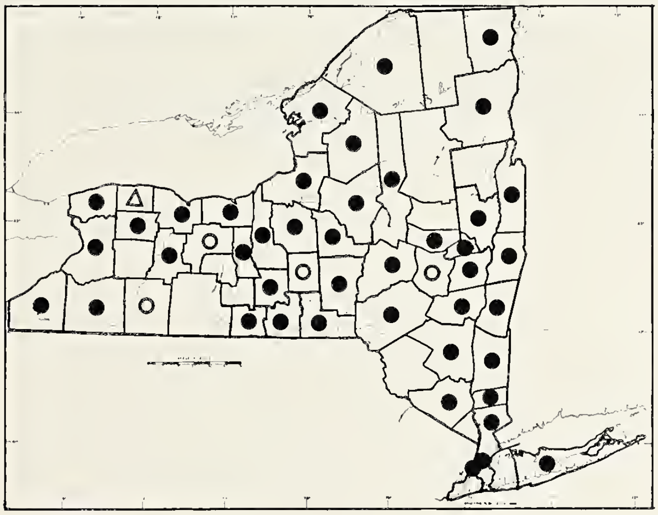
General Distribution: Quebec to Manitoba, Iowa; along the Appalachians south to Georgia

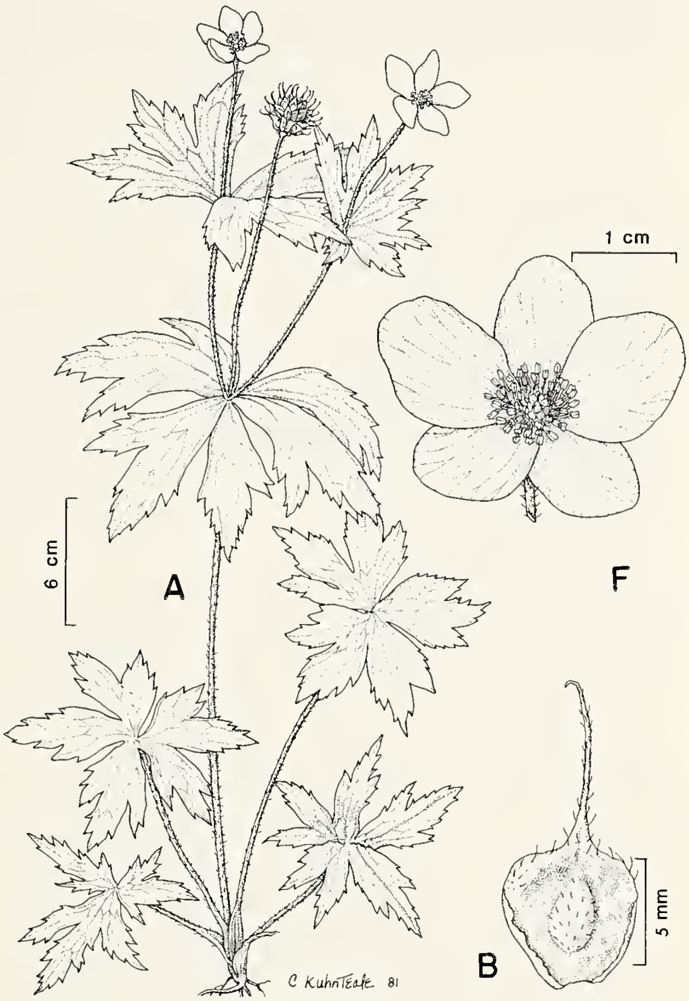


Description: Plants with **bisexual** flowers; **stigma** 1 per ovary, minute, on a tapered, glabrous, slightly recurved **style** ca 1 mm long; **ovaries** 8–18 (21), ca 1 mm long, covered with dense, white hairs, each ovary with a single **ovule** developing; **receptacle** small, capitate, enlarging little in fruit; **achenes** 3.0–4.5 mm long, densely hispid, red-brown, lenticular-ovate, 6–15 in number; **seed** pendulous, 1.5–2.5 mm long; **fruiting heads** capitate, ovoid to cylindric, 6–11 mm in diameter; **stamens** about 40–50; **anthers** minute, ovoid, golden; **filaments** slender, 1–5 mm long; **perianth** (4) 5–9 parted, petaloid; **sepals** free, broadly to narrowly oval, 0.5–1.6 (2.1) cm long, 0.4–1.3 (1.6) cm broad, the inner ones often narrower, white, creamy or tinged with red or blue, glabrous with more or less parallel, dichotomously branching, rarely anastomosing **veins**; **peduncles** slender, densely villous near the flower to less pubescent or nearly glabrous below, 1.8–6.4 long; **flower solitary,** borne on the terminal peduncle; **involucral leaves** (2–4), palmately divided, with 3 main lobes, the lateral ones often incised to, or near the base, making the leaf 5-lobed, variously cut, toothed and serrated, the **terminal leaflet** broadest at or above the middle, leaflets pubescent on the margins, glabrous or less commonly with patches of silky hairs on the surfaces, the leaves oval in outline, 2–8 (10) cm broad, with rhombic to lanceolate-cuneate segments; **basal leaf** like the involucral ones, but with a long petiole; **petioles** slender, 0.5–3.5 cm long in the involucre, 4–14 cm long from the base, villous to glabrous; **stem** slender, glabrous to villous, 4–20 cm (30) tall, from a slender, yellowish **rhizome** with tough, fibrous **roots.** (2n = 32)

Infraspecific Variation: This species belongs to the *A. nemerosa* complex which is widespread circumboreally and variable throughout. North American plants differ from European *A. nemerosa* mainly in stature, leaf lobing and venation of the sepals. Western *A. quinquifolia* var. *oregana* Rob. has larger, blue flowers on short peduncles.

Anemone piperi Britt. of the west shows much similarity to European plants, but has tough, brown, ascending rhizomes. In the southeastern United States the complex is represented by *A. minima* DC. and *A. lancifolia* Pursh, which are also difficult to distinguish to all but the best-trained eye. *Anemone quinquefolia* var. *interior* Fern. is merely a pubescence and branching form, found to be variable within populations (Keener, 1975a). This complex is much in need of study on a worldwide basis.





5. *Anemone canadensis* L.

Common Names: Canada Anemone, Windflower

Type Description: Linnaeus, Systema Nat., ed. 12, vol. 3, App. 231, 1768

Synonyms: *Anemone pennsylvanica* L., *A. dichotoma* L. var. *canadensis* McMill., *A. aconitiifolia* Michx.

Origin: Arctotertiary Forest

Habitat: Moist soil of open woodlands, shores, swales and marshy clearings

Habit: Erect or ascending, perennial herbs

Flowering: May—August

Fruiting: June—October

General Distribution: Gaspé to British Columbia, south to New Mexico in the west, Illinois, New England south along the Appalachians to West Virginia

Description: Plants with **bisexual** flowers: **stigma** minute, 1 per ovary; **style** 1 per ovary, recurved, 0.5–1.0 mm long in flower, persistent, becoming straight, up to 6 mm long, spine-like and short-pubescent in fruit; **ovaries** 15–40, each with one fertile **ovule** (one abortive); **receptacle** small, hemispheric, enlarging little in fruit; **achenes** (2) 8–35 in number, ovoid-lenticular to reniform, somewhat inflated, appearing winged due to the bulge of the single **seed**, villous on the seed-bulge, sometimes on the margins, but otherwise glabrate, red-brown, 3.5–6.0 mm wide, 3–5 mm long, excluding the prominent **stylar beak**; **fruiting heads** capitate to globose, ca 1.5 (0.5–2.2) cm broad (often partially infertile) with the appearance of a spiny globe; **seeds** ca 2 mm in diameter, distinctly outlined in the coats of the larger achenes; **stamens** about 35–60; **anthers** ca 1.5 mm long, oblong, golden; **filaments** 2–3 mm long, slender; **perianth** 5 (6–9) parted, petaloid; **sepals** free, 1–2 cm long, 7–14 mm wide, white (creamy) or pink-tinged, orbicular to narrowly oblong with rounded to obtuse tips (not uncommonly with undulate margins), finely short villous on the abaxial surfaces, virtually glabrous within; **peduncles** 1–3, appressed-villous, 3–18 cm long, the lateral ones sometimes with **involucels**, each peduncle borne from a node with 3 **involucral leaves; flowers** borne singly, 1–3 per plant at the tips of the peduncles; **involucral leaves** sessile or nearly so, 3–15 cm broad and long, 3-lobed (often over half way to the bases), the lobes cuneate, acute tipped, usually sharp-toothed and lobed themselves, villous to glabrescent above, villous below; **basal leaves** with 3–5 major lobes, otherwise like the involucral ones, but petioled; **petioles** 9–24 cm tall from the plant base, villous, grooved, sheathing at bases; stems simple or branched, grooved, villous, up to 8.5 dm tall, from a short, tough (1–3 crowned) **caudex** and slender **rhizome** with fibrous **roots**. ($2n = 14$)

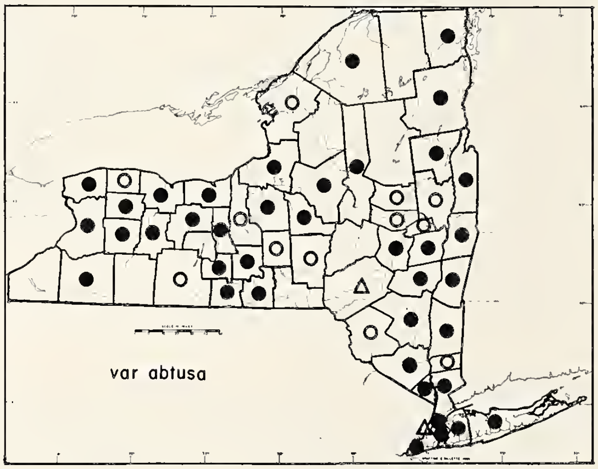
Importance: The plants are sometimes cultivated as an accent to shrubbery or in moist portions of gardens and yards. They escape outside their natural distribution range, and spread aggressively along highways.

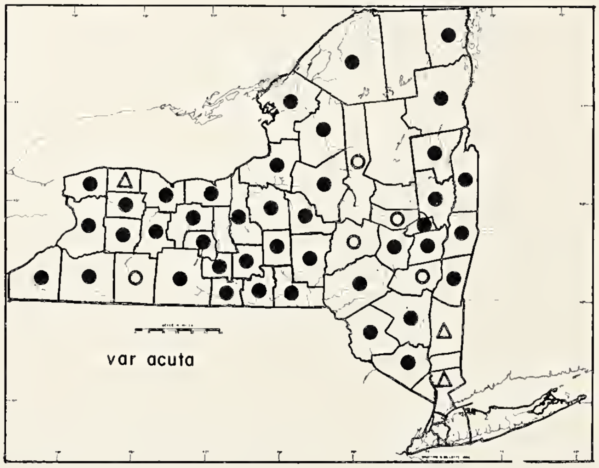
10. HEPATICA

Common Names: Liverleaf, Liverwort

Authority: Miller, Gard. Dict. Abr. ed. 4, 1754

A genus of 2–5 species, depending on taxonomic interpretation. The plants are native to the boreal forests of Europe and eastern North America. They are separated from the genus *Anemone*, where they were placed originally, by their lobed (rather than compound) basal leaves and scapose flowers with involucres in the position of calyces. Two species usually recognized in the United States have been shown to be included in the broad range of variation of *H. nobilis* Schreb. (Steyermark & Steyermark, 1960), and are here treated as varieties of that widespread species. The Hepaticas are widely cultivated, and once were thought to cure liver ailments, due to the liver-like lobing of the leaves.





1. *Hepatica nobilis* Schreb.

Common Names: Liverleaf, Noble Liverwort, Heart Liverleaf, Kidney Liverleaf, Round-lobed Liverleaf (var. *obtusa*), Sharp-lobed Liverleaf (var. *acuta*) Livermoss, Crystalwort, Ivy flower, Herb-trinity, Squirrel-cup, "Spring Beauty", Hepatica

Type Description: Schreber, Spicel. Fl. Lips, p. 39, 1771

Synonyms: *Hepatica americana* (DC.) Ker., *H. acutiloba* DC., *H. triloba* Gilib., "H. *triloba* Chaix" of authors not accepting Gilib. as authority, *H. hepatica* (L.) Karst., *Anemone hepatica* L., *Anemone triloba* (Gilib.) Stokes (See Steyermark, 1960, for additional combinations made for varieties and forms of this species)

Origin: Arctotertiary Forest

Habitats: Moist to dry woods and streambanks

Habit: Scapose, perennial herbs; evergreen

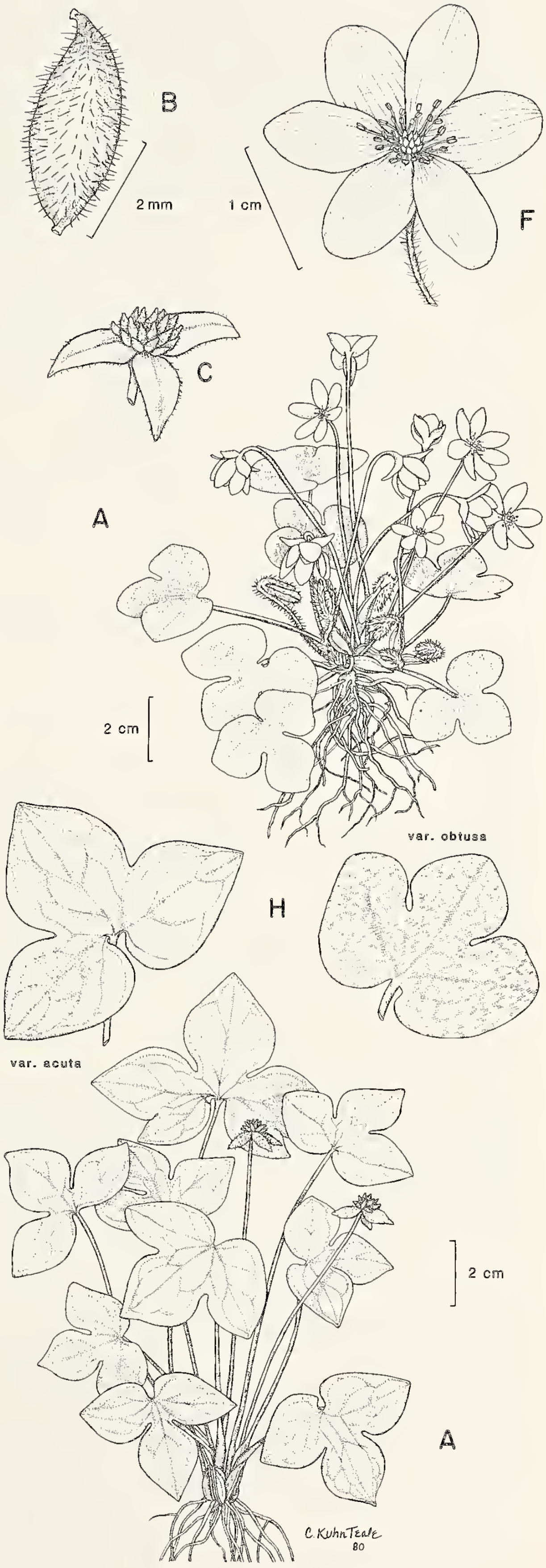
Flowering: March—May

Fruiting: April—July

General Distribution: Nova Scotia to Quebec and Minnesota, south to Georgia with an outlier in Florida (widespread in Europe)

Description: Plants with **bisexual** flowers; **stigma** 1 per ovary, minute to slightly capitate; **style** ca 1 mm long, often bent or reflexed with maturity; **ovaries** 8–15 (20), 1–1.5 mm long, fusiform, with a single **ovule**, hispid, each ovary becoming a fusiform to conic-ovoid **achene**; achenes (3) 8–15 (20), densely hispid, tan to dark brown, 4–5 mm long, ca 1.5 mm wide, borne in hemispheric to capitate clusters, subtended by the involucre; **seed** 1, 1–1.5 mm in diameter; **staminodes absent**; **stamens** numerous, 2–5 mm long; **anther sacs** minute, golden; **filaments** pale, slender; **perianth** of a single series of petaloid lobes; **perianth lobes (sepals)** free, (5) 6–12, oval to linear-oblong, pink, bluish, purple or white, 5–13 (17) mm long, 3–8 (11) mm wide, glabrous or rarely with a few hairs; calyx simulated by an **involucre** directly beneath the flower or up to 5 mm below it; involucre 3-lobed, green, lobes ovate with acute to obtuse or rounded tips, (5) 7–15 (18)mm long, 3–8 (10) mm wide, strongly villous, especially below (to nearly glabrous); **scapes** 1-several per plant, 3–15 (20) cm long, villous, slender, often arching, each bearing a **single flower**; **leaves** 2–10 cm wide, 2–6 cm long, 3-lobed (5–9, less commonly), cordate at the base, strongly villous to glabrescent, pale to dark, shiny green above, often with a blush of rose-purple or maculate, rose-purple beneath; sinuses cut ¼–½ the width of the blade, **lobes** oval to triangular-acute (or acuminate) with rounded to sharply pointed tips; **petioles** slender, 3–18 cm long, densely villous to glabrescent; **stipules** 5–18 mm long, greenish-yellow, oblong to lance-ovate, 3–8 mm wide, arising with the petioles on a short **caudex** at ground level; **rhizome** tough, 2–6 mm in diameter, with tough, twisted and knotted **roots**. (2n = 14)

Infraspecific Variation and Hybridization: It has been traditional to recognize two native species of *Hepatica* in North America. Steyermark and Steyermark (1960) presented convincing evidence that European and American plants show similar variation patterns on both continents and that overlap in characteristics allows no clear distinction between them. Their studies were backed by careful measurements made in the field and on a broad spectrum of herbarium materials. Though recent manuals have likened round-lobed *H. americana* to European *H. nobilis*, the type specimen of *H. nobilis* is closer to what American authors call *H. acutiloba*, round-lobed types being less



common in Europe. Both varieties are found on calcareous to neutral or slightly acidic soils in our range, neither being found predominantly on any soil type. The fact that hybridization occurs and is documented where they are sympatric does not mean that they do not largely maintain their integrity. But to recognize them at the species level when similar variation occurs in Europe only confounds the problem, not to mention nomenclature. Phenotypic modification of the main character of leaf-lobing has been noted after transplant into gardens. It seems appropriate in this case to treat the entities as varieties. Round-lobed plants may sometimes produce 5-lobed leaves; some populations of acute-lobed plants show a tendency to produce 5–9 acute to acuminate lobes per leaf and shallow sinuses. Teratological forms are known in which all flower parts develop into sepals, the inner ones being hispid like achenes.

KEY TO VARIETIES

1. Tips of leaf lobes rounded to blunt.............................*H. nobilis* var. *obtusa* (Pursh) Steyerm.
1. Tips of leaf lobes acute to acuminate..............................*H. nobilis* var. *acuta* (Pursh) Steyerm.

Importance: Hepaticas are relatively popular as garden plants for shaded areas. In ancient times they were thought to cure liver ailments due to leaf shape (by the Doctrine of Signitures). American Indians mixed roots with rhizomes of Maidenhair Ferns *(Adiantum)* for treatment of leukorrhea (*Candida* infections).

11. CLEMATIS

Common Names: Virgin's-bower, Leather-flower, Curlflower

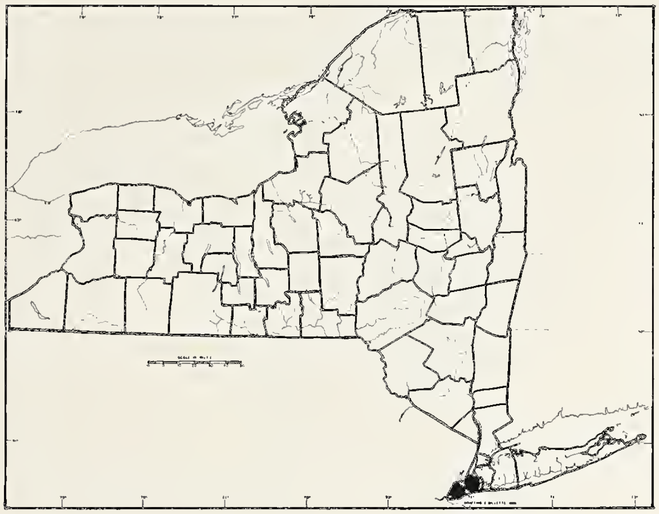
Authority: Linnaeus, Species Pl., p. 543, 1753

The genus *Clematis* has over 200 species worldwide and 25–30 native to boreal and subtropical North America. They are viny or herbaceous and widely cultivated for their great variety of flower colors and shapes, as well as their showy clusters of plume-like fruits. New York State has three native species, one introduced species which escapes cultivation on occasion and two which very rarely escape.

Description: Plants with **bisexual** flowers, **dioecious** or **polygamodioecious**; **stigma** 1 per ovary; **style** 1 per ovary, elongate, persistent, becoming plumose in fruit; **ovaries** 8–12 (20), becoming **achenes**; achenes usually copiously pubescent (along with their plumose styles) forming feathery masses at maturity; **seed** 1 per fruit, with a **raphe**, suspended; **stamens** numerous, often cohering; **staminodes** present or absent; **perianth** of a single series of parts; **perianth lobes** (**sepals**) nearly free to connivent, forming an urceolate cup in some, valvate in bud, a great variety of colors from white or greenish to red, blue, orange or purple; **inflorescence** a panicle, or flowers borne singly (strongly nodding in some species); **peduncles** slender, flexuous (twining in some); **leaves** opposite, simple or usually pinnately or ternately compound; **leaflets** membranaceous to quite leathery, toothed, lobed or entire; **petioles** and **rachises** prehensile in some, aiding the vining process; **stipules** present or absent; **stems** erect, herbaceous to slightly woody or sprawling and vining, arising from tough, perennial **rootstocks**.

KEY TO SPECIES OF CLEMATIS

1. Leaves simple, sessile or nearly so; plants erect or ascending, not viny; petaloid sepals leathery, forming a cup ....1. *Clematis ochroleuca* (p.)
1. Leaves compound, strongly petioled; plants vining or sprawling; petaloid sepals thin, spreading or drooping ....(2)
   2. Flowers or fruit-clusters single in the leaf axils; petaloid sepals 2.5–5 cm long, purplish................ ....2. *Clematis occidentalis* (p.)
   2. Flowers or fruit clusters borne in panicles; petaloid sepals white or creamy, less than 1.8 cm long....(3)
3. Leaflets toothed and lobed, dentate to crenate, borne mostly in threes........3. *Clematis virginiana* (p.)
3. Leaflets usually entire, not toothed and rarely lobed, borne mostly in fives ....4. *Clematis terniflora* (p.)



1. *Clematis ochroleuca* Ait.

Common Names: Leatherflower, Curlyheads

Type Description: Aiton, Hort. Kew., vol. 2, p. 260, 1789

Synonyms: *Clematis sericea* Michx., *Viorna ochroleuca* (Ait.) Small

Origin: Eastern North America

Habitats: Dry, gravelly soil, clearings, thickets, cliffs, open woods (serpentine soil in New York State)

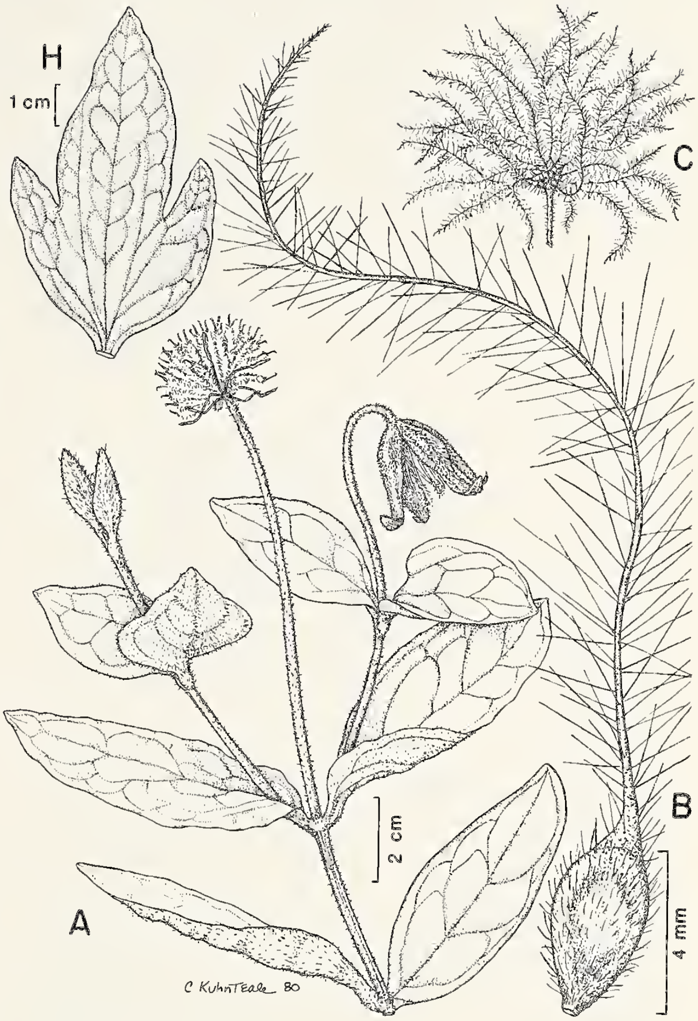
Habit: Erect-ascending, perennial herbs

Flowering: May—June

Fruiting: June—August

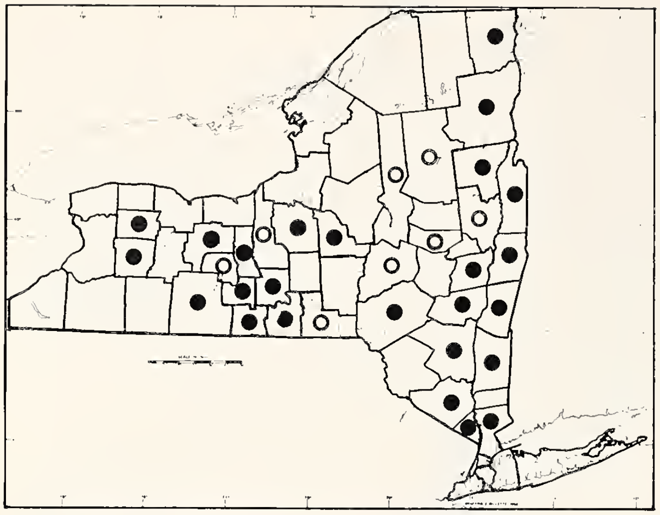
General Distribution: (Staten Island, New York) Pennsylvania along the Appalachian Piedmont to Georgia

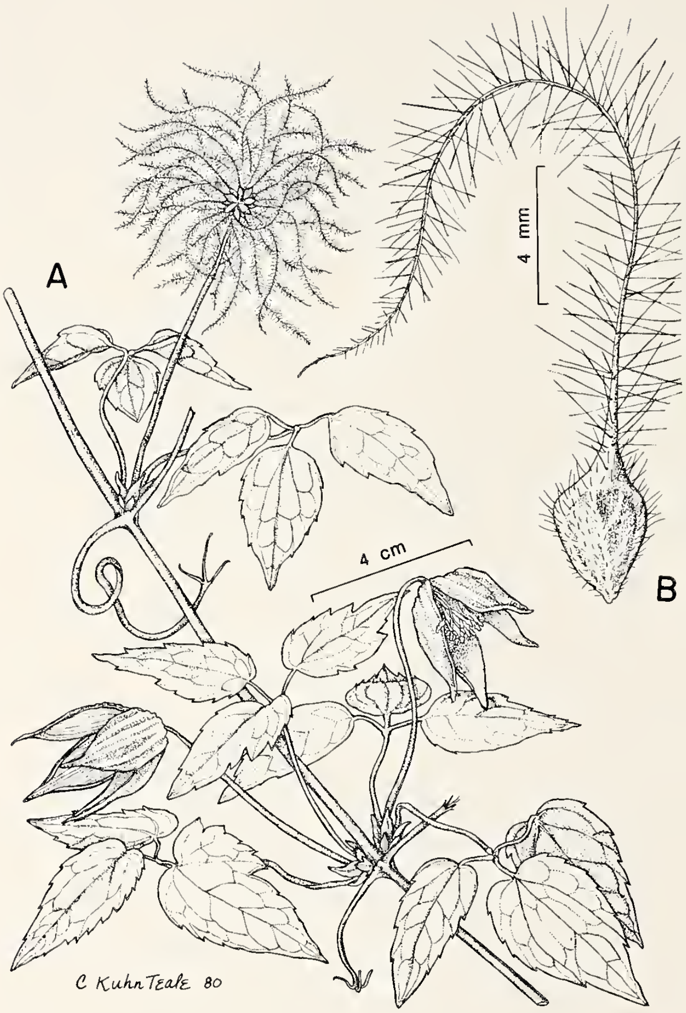
Rarity Status: This species is very rare in New York State (Staten Island only), and appears on the State list of endangered and threatened species



Description: Plants with **bisexual** flowers; **stigma** 1 per ovary, minute; **style** 1 per ovary, 10–15 mm long, cinnamon brown, filiform, densely hispid above to woolly-villous below, persistent, becoming a wiry, flexuous, tawny-hispid **plume,** 4–5 (6) cm long in fruit; **ovaries** 25–40, ca 1 mm long, densely crowded on a dome-like receptacle, becoming distorted, pyriform **achenes**; achenes 3–4.5 mm long, with short, ascending or slightly spreading hairs grading upward into the hispidity of the plumose style; **stamens** numerous, 10–15 mm long; **anthers** linear, 6–9 mm long apiculate tipped; **filaments** winged, 5–10 mm long; **perianth** of a single series of lobes; **perianth lobes (sepals)** usually 4, leathery, free, but curved to form a cup, obspatulate-acuminate to lanceolate with reflexed or curled and contorted tips, (sepals) 1.1–2.6 cm long, 4–9 mm wide, yellowish to purple, but with a highly reflective silver-gray sheen due to the densely sericious abaxial surfaces; **peduncles** 4–15 cm long, growing between flowering and fruiting; **flowers** borne singly at the branch apices; **leaves** opposite, entire (or dentately toothed or lobed), usually sessile 3–9 (12) cm long, 1.5–6 (9) cm wide, broadly to narrowly ovate with obtuse to rounded (acute) tips coriaceous, prominently yellowish-reticulate veined, mature leaves moderately sericeous-pilose below, less so above; **petioles** absent or villous, 1–4 (7) mm long; **stipules absent**; **stems** ribbed, reddish brown, densely silky-pilose to glabrescent, usually with short **side branches** (better developed at lower nodes), erect, 4–9 dm tall, arising from a tough, **perennial stock** with fibrous **roots.** (2n = 16)

Infraspecific Variability: Leaves of some plants may be toothed and lobed, while those of others are entire.





2. *Clematis occidentalis* (Hornem.) DC.

Common Names: Purple Clematis, Purple Virgin's-bower

Type Description: Hornemann, Hort. Reg Bot. Hafn., vol. 2, p 520, 1815

Synonyms: *Clematis verticillaris* DC., *C. hexagona* Eat., *Atragene americana* Sims, *A. occidentalis* Hornem.

Origin: Northeastern North America

Habitats: Rocky, often calcareous woods and thickets

Habit: A climbing or sprawling vine (rarely dwarfed)

Flowering: May—June

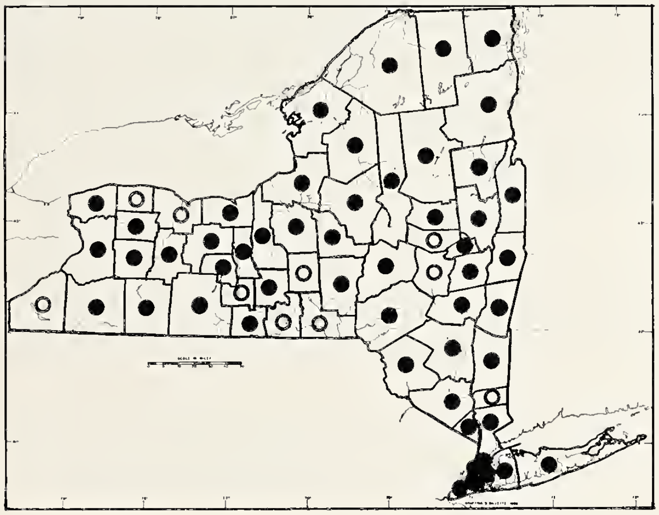
Fruiting: July—September

General Distribution: eastern Quebec to Manitoba (Washington State), south to Iowa, New Jersey, scattered along the Appalachians to Virginia (cultivated elsewhere)

Description: Plants with **bisexual** flowers; **stigma** 1 per ovary, punctate; **style** 1 per ovary, filiform, 7–13 mm long, covered with pale, appressed hairs, persistent in fruit becoming a flexuous, silvery-hispid **plume** 3–5 cm long; **ovaries** 30–40, ca 1 mm long, pilose, with a single **ovule**, densely crowded on a dome-like **receptacle**, becoming a subglobose **head of achenes; achenes** lenticular-ovoid, reddish brown, 3–4 mm in diameter, hispid; **seed** 1 per fruit, ca 2.5 cm in diameter; **stamens** numerous, 1.0–1.5 cm long; **filaments** mostly over 1 cm long, pubescent or glabrous, winged, with the broadest part of the wing (near the anther sacs) up to 3 mm wide (intergrading with staminodia); **anther sacs** golden, 2.5 mm long or smaller (to obsolete); **staminodia** like the filaments or spatulate, up to 5 mm broad at the rounded tips, somewhat petaloid, often villous; **perianth** of 4 large, petaloid sepals; **perianth lobes (sepals)** 2.5–3.8 (6) cm long, 0.9–1.6 (2.5) cm broad, mauve-purple or less commonly blue-violet (white), prominently reticulate veiny, thin (nearly translucent), oblong-elliptic to broadly lanceolate with obtuse to acuminate (or mucronate) tips, with fine, pubescent areas especially along the margins; **peduncles** 4–7 cm long, arising from within the bud scales, ribbed villous to glabrous; the large **flowers** (4–8 cm in diameter) borne singly, usually nodding, in the axils of the leaves; **bud scales** numerous, ovate, 4–6 mm long, 2–3 mm wide, sericeous to almost glabrous within; **leaves** opposite, trifoliate; **leaflets** 2–9 cm long 1–5.5 cm wide, unlobed and ovate, or 2–3 lobed, truncate to cordate at the bases, the margins subentire to dentate or deeply serrate, sparsely villous to glabrescent; **petiolules** and **petioles** villous, petioles often twining, up to 7 cm long; **nodes** enlarged; **internodes** reddish brown to green, usually glabrous; **stem** somewhat woody, climbing up to 30 ft (or trailing) from a perennial **rootstock.** (2n = 16)

Infraspecific Variation: Flower color varies from reddish-purple to blue (rarely white). Variety *grandiflora* Boivin, has large flowers with sepals about 6 cm long. Fernald's var. *cacuminis* was based on immature flowers and deserves no recognition. A short, tufted type of plant occurs disjunct in Washington State, and bears the name var. *dissecta* (C. L. Hitchc.) Pringle.

Importance: This is one of the more beautiful and desirable native plants for cultivation. It is grown all over the boreal world as a trellis plant, and bred for color and flower size.



3. *Clematis virginiana* L.

Common Names: Virgin's-bower, "Woodbine", Devil's Darning-needle, Love-vine, Devil's-hair, Traveler's-joy

Type Description: Linnaeus, Amoen., vol. 4, p. 275, 1759

Synonyms: *Clematis canadensis* Mill., *C. virginica* (in Pursh), *C. fragrans* Salisb., *C. cordifolia* Moench., *C. purshii* Dietr.

Origin: Eastern North America

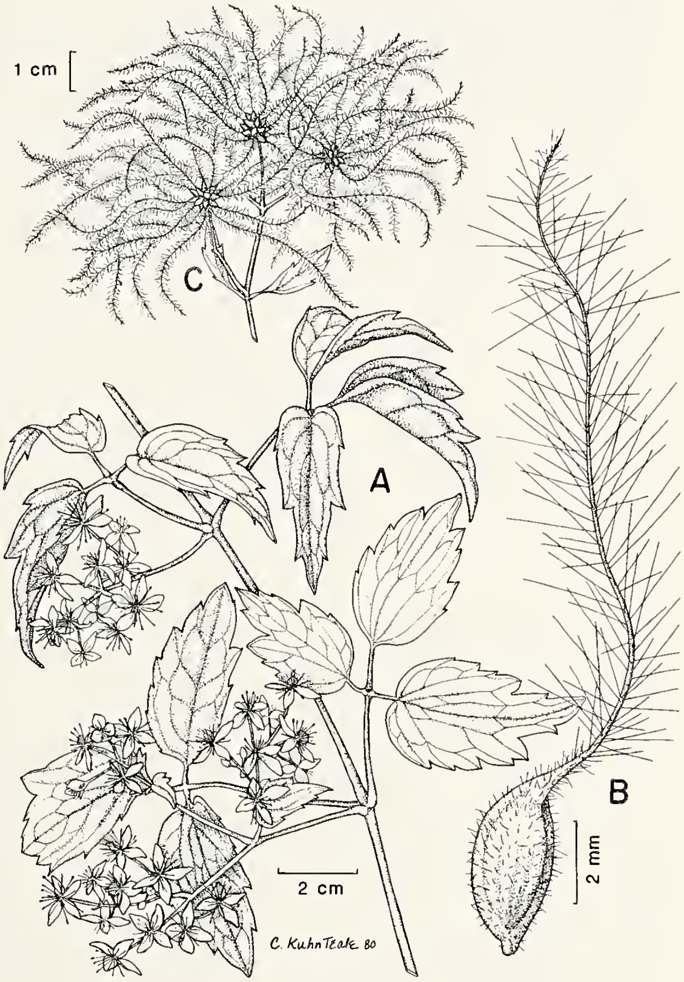
Habitats: Clearings, thickets, open woods and borders, fencerows, roadsides and waste places, usually in poorly drained soil and relatively strong sunlight

Habit: A tangled, matted, perennial vine, sprawling or climbing

Flowering: July—September

Fruiting: August—November

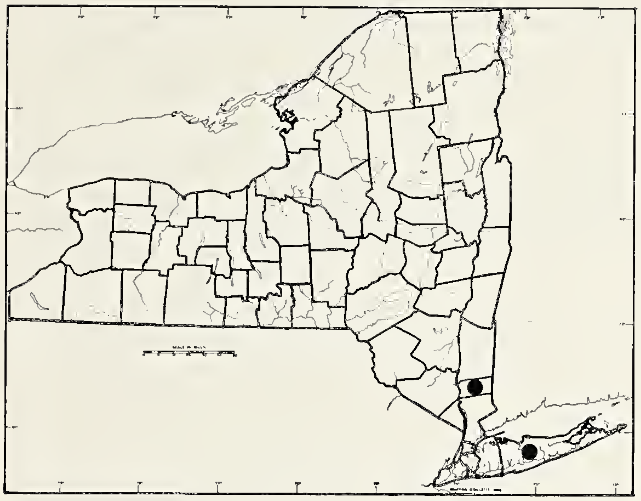
General Distribution: Nova Scotia to Manitoba, west to Nebraska, south to Louisiana and northern Florida

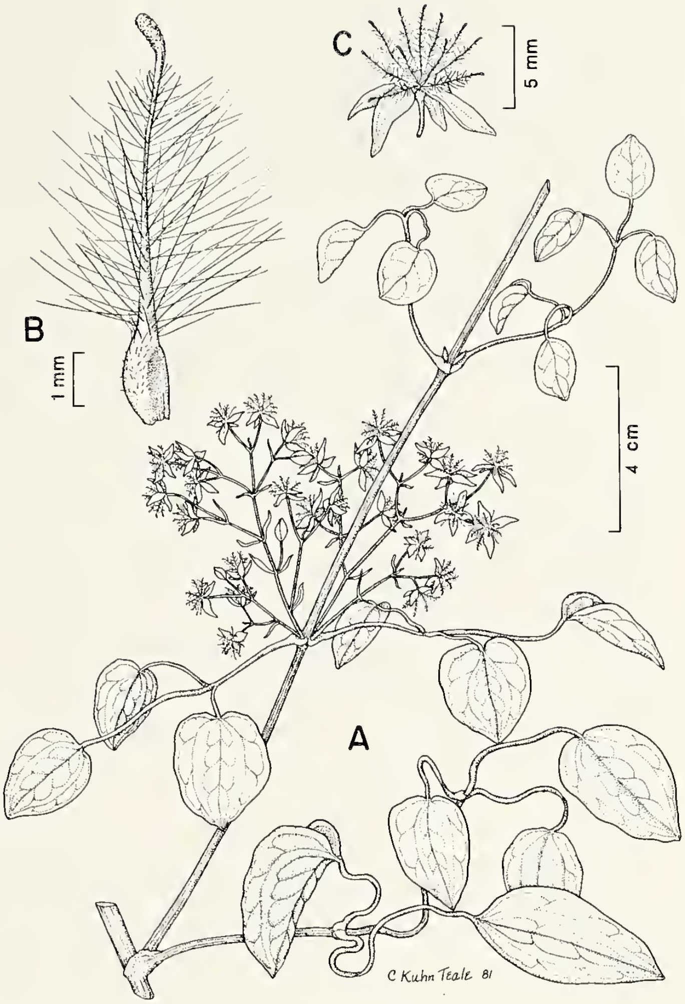


Description: Plants **polygamo-dioecious** or with primarily **bisexual** flowers; **stigma** 1 per ovary, minute; **style** 1 per ovary, filiform, 4–8 mm long, densely covered with silvery, ascending hairs, persistent in fruit, becoming a slender, flexuous, tawny-hispid **plume** 2–3 (4) cm long; **ovaries** 30–50 (60), about 1 mm long, villous, single ovuled, densely crowded on a dome-like **receptacle**, becoming a subglobose **head of achenes**; **achenes** elliptic-lenticular with rib-like margins, falcately distorted toward the persistent style, tan and brown, 2.5–3.5 (4) mm long, 1.5–2.0 mm wide, short-hispid; **seed** 1 per fruit, ca 1.5 mm in diameter; **stamens** 15–25 (30), 2–5 mm long; **filaments** dilated or filiform; **anther** sacs less than 1.4 mm long, golden; **perianth** of a single whorl of 4 free, petaloid lobes; **perianth lobes** (**sepals**) white to ivory, oblong to oval with acute to rounded tips, 8–13 (17) mm long, 2–7 mm wide, sericeous on the adaxial surfaces with densely tomentose bands along the margins, glabrescent within; **pedicels** and **peduncles** villous, ribbed; **inflorescence** of several to many highly-branched panicles borne in the leaf axils; **bracts** like the leaflets or reduced upward to lanceolate, villous structures as few as 2 mm in length; **inflorescence buds** axillary, densely villous; **leaves** opposite, trifoliate (rarely a five-foliate leaf in ours); **leaflets** similar to one another, on puberulent to glabrous **petiolules** of about equal length (1–3 cm), (**leaflets**) 2–10 cm long, 1–8 cm wide, ovate to lanceolate with acute to acuminate tips and obtuse to truncate or oblique-cordate bases, margins (subentire) usually coarsely dentate with mucronate tips or serrate, minutely revolute, often lobed, but not regularly or deeply, very sparsely pilose or nearly glabrous (pilose in a western variety), thin-textured; **petioles** pilose to glabrous, up to 15 cm long, reflexing and entangling other branches and substrates; **nodes** enlarged; **stems** puberulent, greenish to yellow-brown, somewhat woody, climbing or sprawling up to 7 m from a fibrous, perennial **rootstock.** ($2n = 16$)

Infraspecific Variation: This species is a member of a complex whose major variants lie outside our range. Its two most closely related species are *C. catesbyana* Pursh of the southeast and *C. ligusticifolia* Nutt. of the midwest and west. These species are reported to intergrade (Keener, 1975), and are in need of further study. *Clematis virginiana* L. var. *missouriensis* (Rydb.) Palmer & Steyerm. commonly has 5-foliate leaves which are densely pilose beneath.

Importance: This species is an aggressive weed in our range, dragging down livestock fences, invading woodland borders and shading out more delicate vegetation. It can be quite showy on roadsides and fencerows, and is sometimes cultivated as a trellis plant.





4. ***Clematis terniflora DC.***

Common Names: Virgin's-bower, Yam-leaved Clematis

Type Description: DeCandolle, Syst., vol. 1, p. 138, 1824

Synonyms: *Clematis maximowicziana* Franch. & Sav., *Clematis dioscoreifolia* Levl. & Van., *C. paniculata* Thunb., *C. paniculata* var. *dioscoreifolia* Rehd.

Origin: Japan

Habitats: Escaping cultivation to hedgerows, along railroad tracks and in waste places

Habit: Climbing or sprawling vines

Flowering: July–August

Fruiting: August–November

General Distribution: Native of Japan, escaping cultivation in Europe and the United States

Description: Plants with **bisexual** flowers; **stigma** 1 per ovary, linear-clavate ca 1 mm long; **style** 1 per ovary, 3–4 mm long, filiform, densely tufted with silvery hairs, persistent in fruit, becoming a flexuous, silvery-hispid **plume,** 1.8–2.5 (3) cm long; **ovaries** 5–8 (10), ca 1 mm long, with erect, silvery, short, appressed hairs, **single-ovuled,** mostly erect on a small **receptacle,** becoming a dense **cluster of achenes**; **achenes** oval, glabrous or minutely appressed-pubescent, 5–7 (9) mm long, 2–4 mm wide; **seed** 1 per fruit, ca 3 mm in diameter; **stamens** (9) 10–22 in number, (3) 4–8 mm long; **filaments** 2–5.5 mm long, filiform to slightly flattened; **anther** sacs 1.5–2.8 mm long, oblong, golden; **perianth** of a single whorl of 4, free, petaloid lobes; **perianth lobes** (sepals) oblong to linear-spatulate, 0.6–1.3 (1.7) cm long, 3–6 mm wide, white to creamy, flocculose in bud, the mature sepal glabrescent except for densely tomentose bands along the abaxial margins; **pedicels** and **peduncles** sparsely to densely tomentose or villous; **inflorescence** of few to many branched panicles borne in the leaf axils; **bracts** minute, villous, linear to spatulate, grading into leaflets below; **inflorescence buds** axillary, minute, floccose; **leaves** opposite, usually 5-foliate (or trifoliate); **leaflets** orbicular to ovate-cordate with obtuse to rounded tips (less commonly lobed), 1–6 (9) cm long, 1–5 (7) cm wide, glabrous to puberulent, coriaceous with arching major veins (much as in a yam, *Dioscorea*) and entire margins which are often undulate; **petiolules** and **petioles** sharply grooved (caniculate), villous to glabrous, petioles up to 11 cm long, twining, flexuous; **nodes** somewhat enlarged; **stems** deeply caniculate-grooved, mostly glabrous, greenish-tan, slightly woody, vining up to 5 m from a tough, perennial **rootstock.** (2n = 16, 48, 64)

Importance: This species is commonly cultivated as a trellis plant.

Rare Garden Escapes: Two additional species of *Clematis* are known to escape cultivation in New York State very rarely; these are *C. recta* L. and *C. viticella* L. *Clematis recta* is herbaceous, but erect-ascending, with a somewhat shrubby appearance and fragrant, white flowers. *Clematis viticella* is a climber with giant purple, rose or white flowers.

12. RANUNCULUS

Common Names: Crowfoot, Buttercup, Spearwort

Authority: Linnaeus, Species Pl., p. 548, 1753

This is a genus of 250–300 species, widely distributed world-wide in arctic to boreal and subtropical climates. Habitats vary from alpine fell-fields to dryish sandy sites, deep forest, palustrine or fully submerged-aquatic situations. They are sometimes cultivated in moist gardens. Buttercups usually contain acrid juices and may be regarded generically as poisonous.

Description: Plants with **bisexual** flowers (rarely polygamous); **stigma** 1 per ovary, small; **style** 1 per ovary (or obsolete), often persistent in fruit; **ovaries** few to very numerous, uniovulate, spirally arranged on a glabrous or pubescent **receptacle**, becoming a globose to narrowly cylindric **head of achenes**; **achenes** often **beaked** with a persistent style, their surfaces usually firm (spongy to papery), glabrous to hispid or muricate; **stamens** ten (rarely fewer) to many; **staminodes absent** in normal flowers; **perianth** of two whorls; **petals** yellow or white (rarely red-tinged), often 5 in number (absent to numerous), early or late deciduous, short to long-clawed at base, with a small, simple, adaxial **nectary gland** and an associated **scale** (rarely absent) toward the petal base; **sepals** often 5 (3–6, rarely absent) usually green (or yellowish to purple), spreading or reflexed; flowers on elongating **pedicels** or **peduncles**, single, axillary, or **inflorescence** obscurely corymbose or cymose; **leaves** simple to highly lobed and compound, often with marginal **hydathodes**, leaf shape often modified by water contact or submergence, $[CO_2]$, temperature or day length; plants frequently **heterophyllous** and often with morphological differences between cauline and basal leaves; **cauline leaves** usually alternate, often dissected and sessile; **basal leaves** usually larger, less dissected or entire and petioled; **petioles** usually sheathing at the bases; **stems** erect to prostrate, sometimes slightly succulent, often hollow, bases fibrous to fleshy, annual or perennial; **stolons** often present, the plants perennating by them, or by **corms** or **rhizomes**; **roots** filamentous to fleshy-succulent.

Hybridization: Hybridism is seldom reported for *Ranunculus*. This is surprising given the gross similarity of the flowers and the morphological similarity, if not intermediacy, of many of the eastern North American species. Indeed it may be possible that several "species" may merely be based on a few dominant characteristics. Sobel (1977) has shown that *Ranunculus abortivus* and its allies, *R. micranthus* and *R. allegheniensis* are apparently interfertile. It might have been interesting to include other small-flowered Buttercups like *Ranunculus recurvatus* in these breeding experiments. So little is known about the genetics and reproductive biology of eastern North American species that the wisest course, at present, seems to be to adopt a very traditional species concept.

KEY TO RANUNCULUS SPECIES

1. Plants with submersed, aquatic leaves dissected into numerous, capillary segments....................(2)

1. Plants without capillary-dissected leaves (even if submersed)..(4)

    2. Petals white, (often yellow-clawed); achenes transversely ridged, not corky at bases................(3)

    2. Petals yellow; achenes not transversely ridged, corky thickened at bases..............................1. *Ranunculus flabellaris* (p.)

3. Beak of achene (0.3) 1.0–1.5 mm long; leaves somewhat rigid, retaining their outline when removed from water; style ± straight, subulate, persistent............................2. *Ranunculus longirostris* (p.)

3. Beak of achene absent or merely an apiculate remnant of the deciduous style (0.1–0.3 mm long); leaves usually flaccid, collapsing and not retaining their outline when out of water; style subulate or capitate, usually bent 90° from near base, deciduous ....3. *Ranunculus trichophyllus* (p.)

    4. Sepals 3; leaves ovate with cordate bases; stigma sessile (style obsolete); small bulbils produced in leaf axils after flowering ....4. *Ranunculus ficaria* (p.)

    4. Sepals usually 5; leaves various; style short to elongate; bulblets absent from axils of leaves.........(5)

5. Pericarp of achene thin, papery, surface with longitudinal ribs, glabrous (vegetatively with small, rounded-crenate leaves and stolons; halophytic)................................5. *Ranunculus cymbalaria* (p.)

5. Pericarp of achene firm or spongy, not longitudinally ribbed, surface glabrous, papillate, pubescent or spiny ....(6)

    6. Basal leaves lanceolate, linear or spatulate...(7)

    6. Basal leaves dissected, deeply lobed or unlobed, but not lanceolate, linear or spatulate ....(8)

7. Plants with slender, arching stolons; leaves narrow, tufted, blades not expanded or less than 1 cm wide; sepals 2–4 mm long .... 6. *Ranunculus reptans* (p.)

7. Plants adventitiously rooting from stout, prostrate bases; leaf blades 1–3 cm wide; sepals 5–7 mm long .... 7. *Ranunculus ambigens* (p.)

8. Leaves all simple, unlobed, the lower ones ovate to oblong, occasionally with shallow dentations .... 8. *Ranunculus pusillus* (p.)

8. Leaves (cauline) commonly deeply lobed or compound .... (9)

9. Achenes (ovaries) smooth, pubescent, shallowly pitted or minutely papillate but not spiny .... (11)

9. Achenes (ovaries) spiny .... (10)

10. Spines of achenes slender; petals (1–) 3–4 mm long; achenes about 1.5 (–3) long .... 9. *Ranunculus parviflorus* (p.)

10. Spines of achenes stout; petals 4–8 (–12) mm long; achenes about 5 (–7) mm long .... 10. *Ranunculus arvensis* (p.)

11. Basal leaves all dissected or lobed, not ovate, circular or reniform .... (14)

11. Basal leaves undissected and dissected, ovate circular or reniform .... (12)

12. Beak of achene (style) straight or slightly curved, 0.2 mm long or less; achenes about 1.3 (1.1–1.5 mm long .... (13)

12. Beak of achene (style) strongly recurved, 0.7–1.0 mm long; achenes about 1.8 (1.5–2.0) mm long .... 11. *Ranunculus allegheniensis* (p.)

13. Basal leaves reniform or circular in outline; leaf bases cordate; receptacle pubescent throughout .... 12. *Ranunculus abortivus* (p.)

13. Basal leaves ovate; leaf bases cuneate or truncate; receptacle mostly glabrous (sometimes pubescent at the summit only) .... 13. *Ranunculus micranthus* (p.)

14. Terminal leaflets with definite, unwinged petiolules; larger leaves mostly compound .... (18)

14. Terminal leaflets or lobes without definite petiolules (or narrowed to wings at base); larger leaves merely deeply lobed .... (15)*

15. Achenes flattish, compressed, conspicuously beaked; plants pubescent (except a form of *R. recurvatus*) .... (16)

15. Achenes biconvex, plump, minutely beaked; plants glabrous .... 14. *Ranunculus sceleratus* (p.)

16. Stigma minute and terminal, usually deciduous; beak 1.0–2.3 mm long, subulate to deltoid .... (17)

16. Stigma lateral on the upper portion of the style, persistent; beak 0.4–1.0 mm long, deltoid .... 15. *Ranunculus acris* (p.)

17. Achene beak hooked or coiled; petals about 5 mm long .... 16. *Ranunculus recurvatus* (p.)

17. Achene beak subulate, ± straight; petals 7–14 mm long .... 17. *Ranunculus hispidus* (p.)

18. Plants with bulbous, corm-like bases; sepals strongly reflexed at their bases .... 18. *Ranunculus bulbosus* (p.)

18. Plants without corm-like bases; sepals spreading, not reflexed but occasionally lax with age .... (19)

19. Plants stoloniferous .... (22)

19. Plants not stoloniferous .... (20)

20. Stem bristly-hairy; achenes in a cylindric head; petals less than 6 mm long, not longer than sepals .... 19. *Ranunculus pensylvanicus* (p.)

20. Stems villous or hispid, not bristly; achenes in a globose head; petals over 6 mm long, longer than sepals .... (21)

21. Larger leaves pinnately divided; some roots fusiform-tuberous .... 20. *Ranunculus fascicularis* (p.)

21. Larger leaves 5-palmately divided (or ternate); fleshy roots narrowly elongate, not fusiform .... 17. *Ranunculus hispidus* (p.)

22. Achene beak 1.5–3.0 mm long; stigma minute, terminal, usually deciduous in fruit .... 17. *Ranunculus hispidus* (p.)

22. Achene beak 0.7–1.4 mm long; stigmatic surface somewhat diffuse on upper portion of style, usually persistent in fruit .... 21. *Ranunculus repens* (p.)

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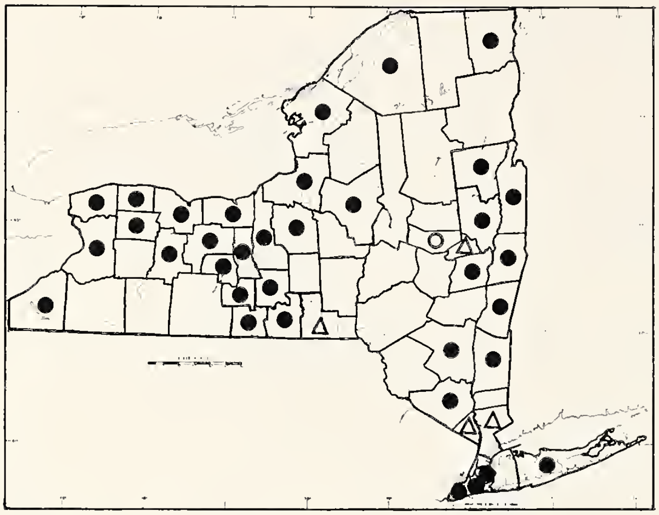
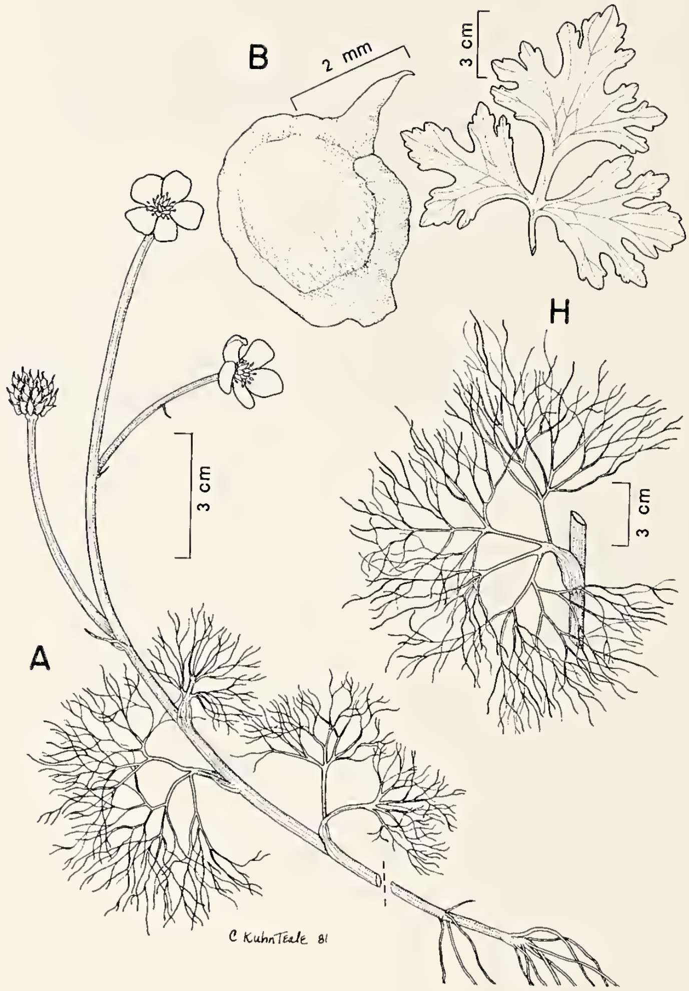
* Sterile, emergent plants of *R. flabellaris* will key to this point.





1. *Ranunculus flabellaris* Raf. ex Bigel.

Common Name: Yellow Water-crowfoot

Type Description: Rafinesque in Bigelow, Amer. Mo. Mag. 2: 344, 1818

Synonyms: *Ranunculus multifidus* Pursh, *R. delphinifolius* Torr., *R. lacustris* Beck & Tracey, *R. fluviatilis* Bigel.

Origin: Boreal North America

Habitats: Shallow water or damp ground of swamps, thickets, ponds and ditches

Habit: Palustrine or aquatic perennials

Flowering: May–July (September)

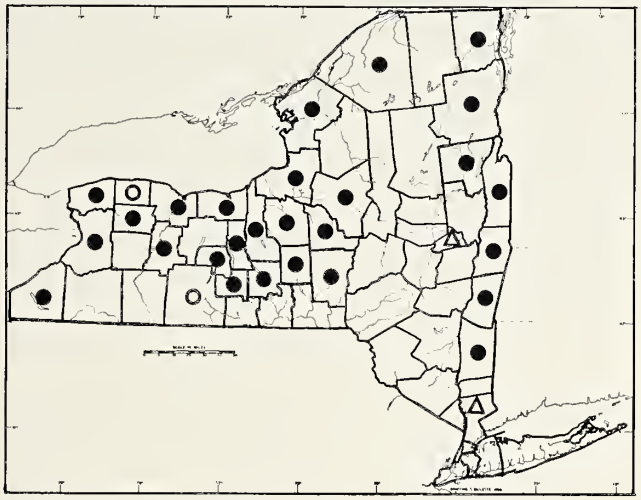
Fruiting: May–July (September)

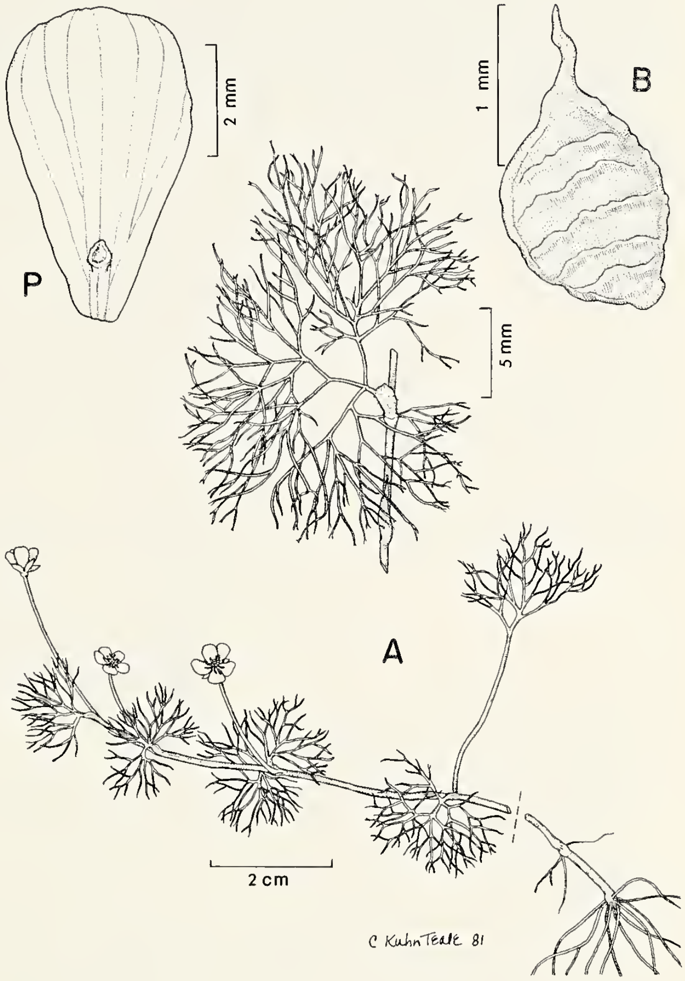
General Distribution: Maine to British Columbia, south to North Carolina, Louisiana, Oklahoma, Utah and California

Description: Plants with **bisexual** flowers; **stigma** 1 per ovary, small, apical; **style** 1 per ovary, terete, tapered, eccentric, sometimes bent, ca 0.5 mm long; **ovaries** (35) 50–75, about 2 mm long, arranged spirally on a compact, ovoid, somewhat hairy **receptacle**, 2–3 mm long, becoming an ovoid **cluster of achenes**; **achenes** 1.5–2.5 mm long, each with a **persistent style (beak)** ca 1 mm long, often at a right angle to the achene body, achene surfaces glabrous with a spongy covering of **floatation tissue** on the lower third of the achene, extending to the base of the beak on the ventral side and about ¾ the way up the dorsal side, the remainder of the dorsal side keeled; **stamens** 50–80; **anthers** oblong, 1–1.5 mm long; **filaments** often flattened, 2.5–3.0 mm long; **petals** 5 (6–8), yellow, obovate, glabrous, 7–22 mm long, 4–14 mm wide, with a **primary nectary scale** 1.5–2 mm long, partially adnate to the petal base, but with free sides and notched tip; **nectary gland** at the base of primary scale covered by a short **secondary scale**; **sepals** 5, yellow-green, glabrous, ovate, 5–12 mm long, 4–7 mm wide, spreading, deciduous before petals; **inflorescence** obscurely racemose, of solitary flowers on elongating **petioles**; petioles 0.5–12.0 cm long (in flower); **bracts** small, auricled; **leaves** alternate; **emergent leaves** generally reniform in outline and ternate, the ultimate lobe 3-toothed or lobed, the lateral ones less regularly incised, sometimes to near the base, leaf blades 0.4–4.5 cm broad; **submerged leaves** with much-divided blades ovate-cordate to reniform in outline, 1.5–10. cm long, 2–12 cm broad; triternately dissected or forked into flaccid, flattened, linear-filiform or narrowly oblong segments 1–2 mm wide; **petioles** 1–20 cm long; **stipules** present, up to 6 mm long, adnate to petioles with broad, flaring, ciliate margins; **stems** branched, hollow, floating or sprawling on mud; **roots** adventitious at the lower **nodes**, especially in stranded plants.

Infraspecific Variation: Like most plants which approach the amphibious habit, this species may be confusing due to heterophylly.

Importance: As a colonizer of swamp pools, this species is eaten by waterfowl and provides excellent habitat for small invertebrates and minnows. *Ranunculus* species are reported to be poisonous.





2. ***Ranunculus longirostris*** **Godr.**

Common Names: White Water-crowfoot, Stiff Water-crowfoot

Type Description: Godron, Mem. Soc. Roy. Nancy, vol. 1839, p. 39, 1840

Origin: North America

Synonyms: *Ranunculus subrigidus* Drew (N.Y. reports), *R. circinatus* of Amer. auth. not Sibth., *R. hydrocharis* Spenn. forma *longirostris* (Godr.) Hiern., *R. aquatilis* var. *longirostris* (Godr.) Lawson, *R. circinatus* var. *subrigidus* (Drew) Benson (N.Y. reports), *Batrachium longirostre* (Godr.) F. Schulz, *B. usneoides* Greene

Habit: Perennial aquatics with submerged leaves and stems

Habitats: Lakes, ponds, slow streams, in basic to circumneutral water

Flowering: June–August

Fruiting: June–September

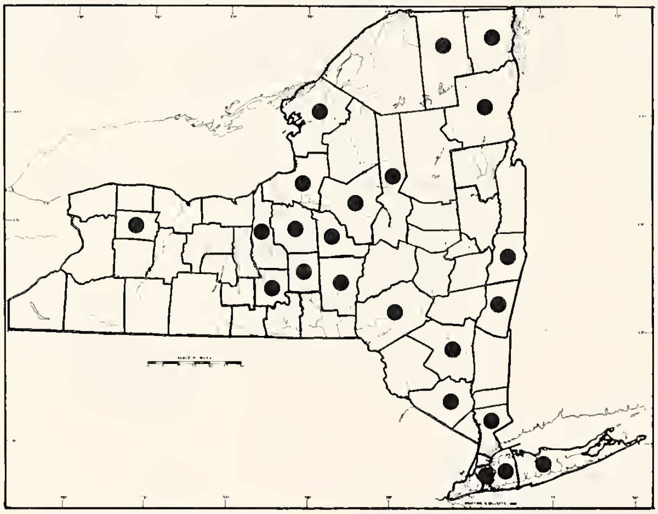
General Distribution: Mostly continental in the Northern United States and adjacent Canada, scattered southward to Deleware, Tennessee, Texas, New Mexico and Arizona

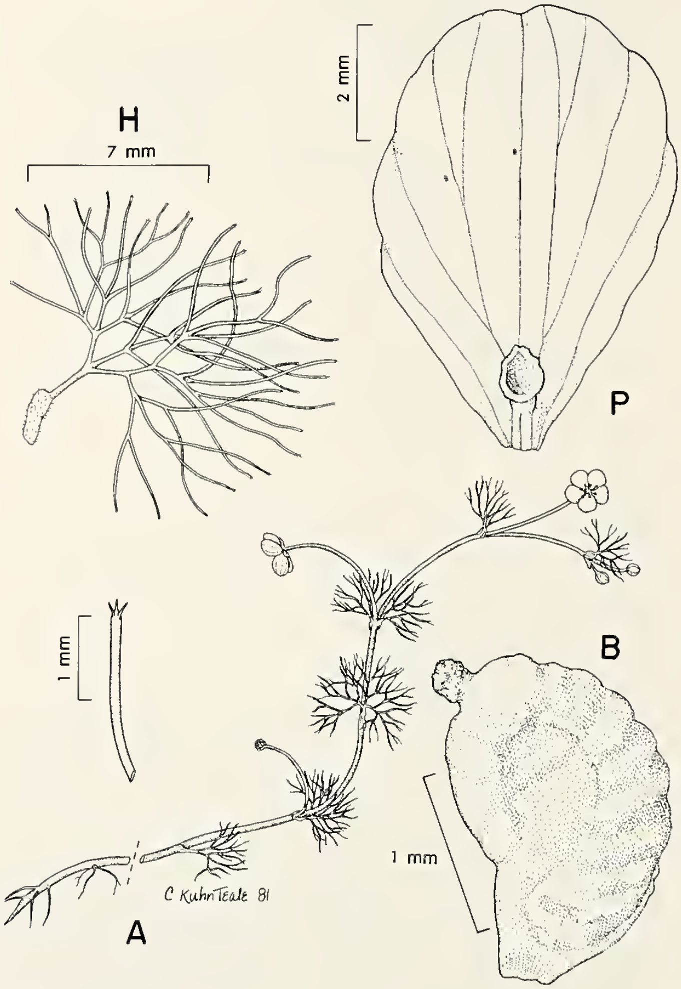
Description: Plants with **bisexual** flowers; **stigma** 1 per ovary, minutely glandular, diffuse over ⅓ to all of the style; **style** 1 per ovary, ± straight, apical but adaxially eccentric; **ovaries** (7) 16–20 (25), ca 1 mm long on a hispid, globose or clavate receptacle, becoming a globose **head of achenes** up to 6 mm in diameter in fruit; **achenes** plump, biconvex, obovate, 1.3–1.7 mm long, transversely ridged, margined, glabrescent; **persistent style (beak)** 0.3–1.5 mm long, straight or ± twisted; **stamens** 10–20, hypogynous, about 1.5 mm long; **anthers** ca 0.5 long, elliptic; **petals** usually 5, white with a yellow blotch at the base, obovate, clawed, 4–9 mm long, 2–5 mm wide; **nectary scale** situated adaxially above the petal claw, forming a small pocket, a crescent-shaped ridge or obsolete;

nectariferous gland minute (less than 0.3 mm wide); **sepals** 5, 3–5 mm long, 2–3 mm wide, ovate, cucullate, yellowish-green to purplish on margins, spreading or tardily reflexed, deciduous; **flowers solitary,** emergent, 1 to several per branch, terminal (or appearing axillary due to sympodial growth of stems); **pedicels** 3–5 cm long, glabrous; **leaves homophyllous,** submerged unless stranded, alternate, hemi-circular to venate with truncate to cordate bases, 1–2 cm broad, dissected into numerous **capillary segments,** but stiff, usually retaining their shape when removed from water, the leaf segments twice trichotomously branched near the leaf base, dichotomously branched distally; **petioles** obsolete or up to 2 mm long connecting the blade with its sheathing **stipular base**; stipular sheaths adnate for ½–¾ of their 4–8 mm lengths, auricled, hispid-fringed and sometimes pubescent below; **stems** hollow, branched, about 2–3 mm in diameter, sometimes pubescent, not lacunate, up to 2 m long; **internodes,**especially the lower ones, much longer than the associated leaves; **lower nodes** often with filiform **roots,** the plants sometimes reproduced vegetatively by **rooting fragments.** (2n = 32)

Infraspecific Variation: Plants somewhat intermediate between this species and *R. trichophyllus* are known. To further confuse matters, an entity described as *R. subrigidus* Drew is vegetatively intermediate, but has a larger number of achenes per head, [30–45 (80)] than any New York State specimens seen.

Importance: *Ranunculus* species are reported to be poisonous to mammals, but this species is eaten by waterfowl.





3. *Ranunculus trichophyllus* Chaix ex Vill.

Common Names: White Water-crowfoot, Limp, White Water-crowfoot

Type Description: Chaix, in Vill., Hist. Pl. Dauph., p. 335, 1786

Synonyms: "*Ranunculus aquatilis* L." of New York authors, *R. capillaceus* Thuill, *R. aquatilis* var. *capillaceus* (Thuill.) DC., *Batrachium trichophyllum* (Chaix) Schultz (for extensive synonymy of the species, see Drew, 1936; Cook, 1966)

Origin: Uncertain (circumboreal and austral)

Habitats: Streams, rivers and lakes

Habit: submerged, aquatic perennials

Flowering: June–August

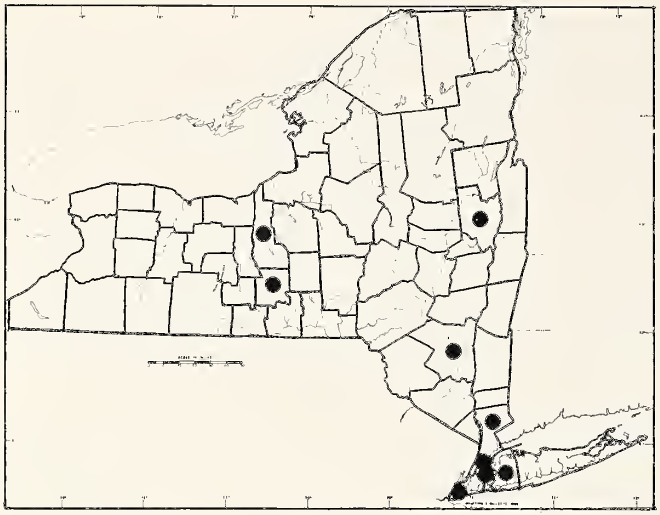
Fruiting: June–August

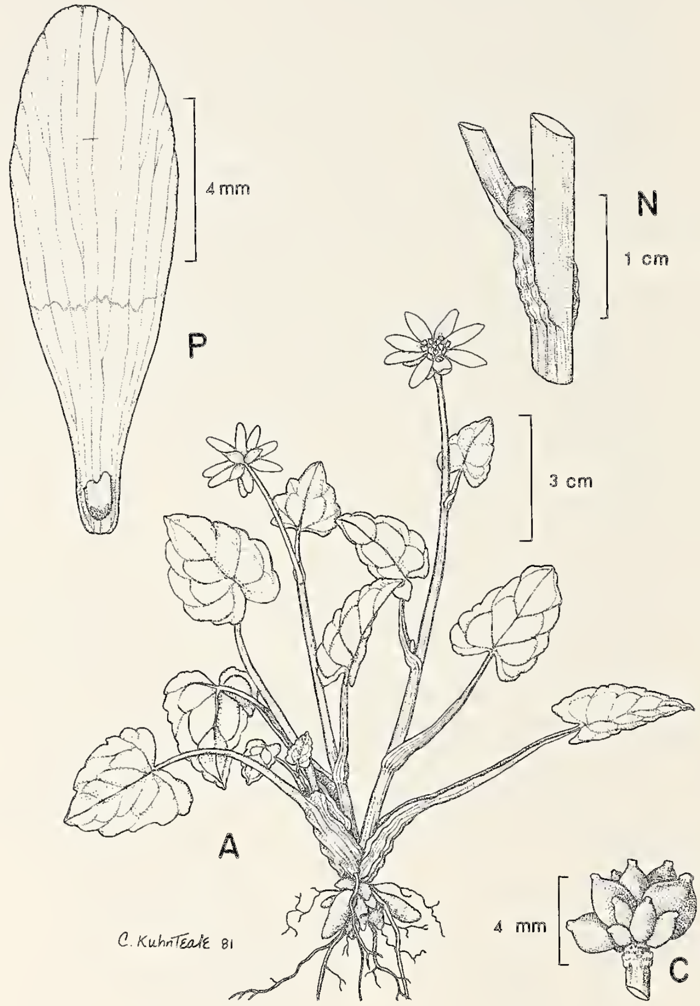
General Distribution: Boreal North America and Eurasia, eastern Australia (in North America south to North Carolina and Baja California)

Description: Plants with **bisexual** flowers; **stigma** 1 per ovary, diffuse over most of the **style**; style 1 per ovary, clavate or slenderly subulate, 0.3–0.7 mm long, apical but adaxially eccentric, often bent 90° from near the base, deciduous in fruit; **ovaries** 10–25, ca 1 mm long, usually densely hispid with two types of hairs, some hairs constricted at base and deciduous, ovaries clustered on a globose or clavate, hispid to glabrous **receptacle,** becoming a globose **head** up to 3.5 mm in diameter; **achenes** plump, biconvex, obovate, 1–1.5 mm long, transversely ridged, margined, glabrous or hispid, apiculate or slightly **beaked** by a small **style remnant** 0.2–0.5 mm long; **stamens** (5) 10–25 (30), hypogenous, 1.5–2.1 mm long; **anthers** short-elliptic; **petals** usually 5, white, with a yellow blotch at base, 4–8 mm long, 2–4 mm wide, clawed; **nectary scale** generally reduced to a crescent-shaped ridge or obsolete; **nectariferous gland** located on the petal near its base adjoining the claw; **sepals** 5, 3–6 mm long, somewhat cucullate, yellowish-green (rarely purple-tipped), spreading, deciduous; **flowers** 1—several per plant, terminal or seemingly axillary due to sympodial growth, solitary on individual **pedicels**; pedicels 1–6 cm long, recurved, mostly submerged; **leaves homophyllous,** submerged unless stranded, alternate, much dissected, flabelliform, 1.5–6 cm long, variously contorted by water currents and usually collapsing when drawn from the water, limp, dissected into capillary segments, once to several times trichotomously branched near base, dichotomously branched distally, often minutely pubescent, the tips minutely hispid usually with at least a pair of tiny hairs; **petioles** 2–20 (40) mm long (rarely sessile toward the apex of the **stipular base**; stipular sheaths 1–5 mm long, adnate to the petiole at least for ⅔ its length, auricled or tapering, glabrous to hispid; **internodes** about as long as their associated leaves; **stems** hollow, ca 1 mm thick, up to 2 m long, glabrous or pubescent, not lacunate; **roots** filiform, usually associated with the lower **nodes**, the plants sometimes reproducing by **rooting fragments** (2n = 32)

Infraspecific Variation: Plants with glabrous mature achenes and receptacles have been called *R. aquatilis* var. *calvescens* Drew. Plants of streams and cold, running water in the Catskills, Adirondacks and on Long Island have long leaf segments, diffuse leaves and long internodes when compared with plants of lakes and ponds of the western and northwestern parts of the state. Whether these differences are phenotypically induced or the product of a genetically based dimorphism remains to be studied experimentally. As with *R. longirostris*, some plants show the intermediate characteristics of *R. subrigidus* Drew, but do not have enough achenes per head to be referred to that taxon. Hybrids with *R. longirostris* are suspected.

Importance: These plants are colonizers of swift flowing streams where little else will grow. They provide habitat for microinvertebrates. *Ranunculus* species are reported to be poisonous.





4. ***Ranunculus ficaria*** **L. ssp.** ***bulbifera*** **Lawal. ex Rob.**

Common Names: Lesser Celandine, Pilewort, Pilewort Buttercup, Crain, Wordsworth's-flower, Fogwort, Golden Cup, Golden Guineas

Type Description: Linnaeus, Species Pl., p. 550, 1753

Synonyms: *Ficaria verna* Huds., *F. ranunculoides* Moench., *F. ficaria* (L.) Karst.

Origin: Europe

Habitats: Moist ground, streambanks, pastures, lawns, open woods and waste places

Habit: Low growing, sprawling or erect perennial, often forming pure stands

Flowering: April–May

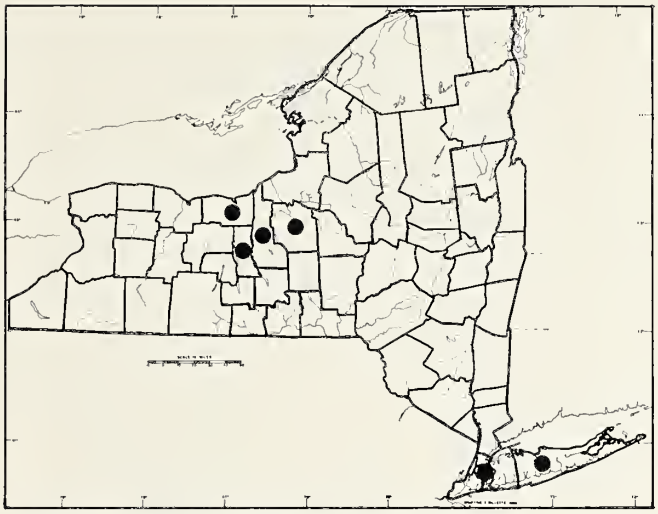
Fruiting: (rarely) May–June

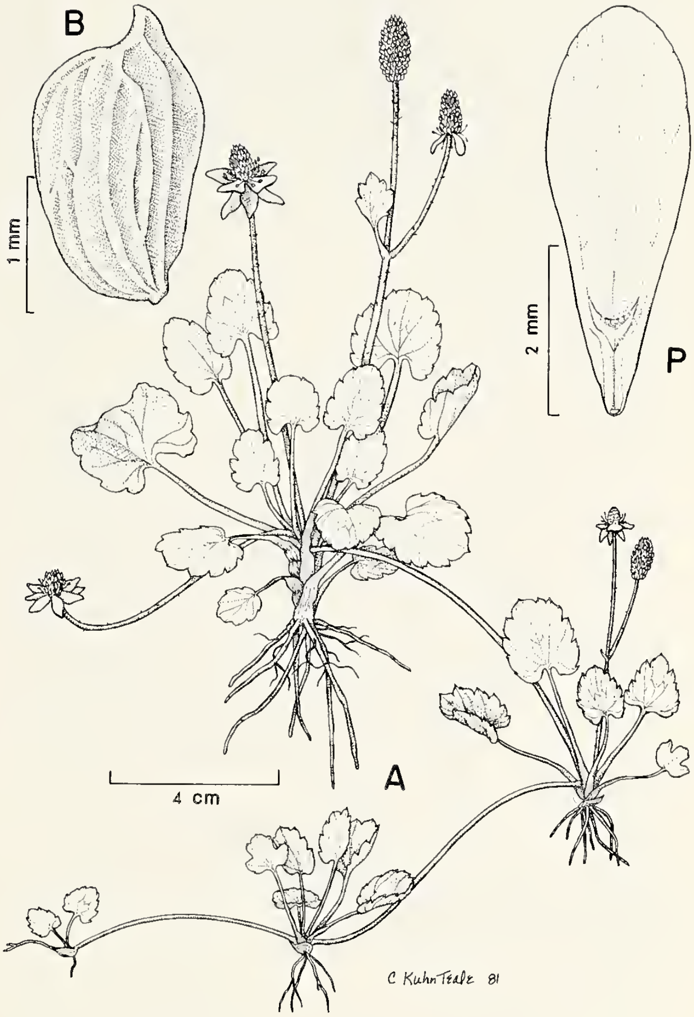
General Distribution: European introduction from Mass. to South Carolina

Description: Plants with **bisexual** flowers; **stigma** one per ovary, sessile and apical; **style lacking; ovaries** 5–44 (72), clustered on a 1–2 mm long, granular, ovoid, **receptacle,** becoming when fertile an ovoid **head of achenes,** ca 2–5 mm in diameter; **achenes** smooth, narrowly obovoid, biconvex, pubescent to glabrous, ca 2.5 mm long, **beakless; stamens** 14–26 (49) hypogynous, 1–4 mm long; **anthers** globose-elliptic; **filaments** linear; **petals** 7–11 (13), yellow (to white), narrowly obovate, 8–15 mm long, 3–7.5 wide; **nectary scales** small, pocket-like, at the petal bases; **sepals** 3 (4), yellow-green, 5–10 mm long, 3–6 mm wide, deciduous, elliptic, glabrous; **flowers solitary** on glabrous **peduncles;** peduncles 1–7 cm long in flower, 3–8 cm in fruit; **cauline leaves** alternate to opposite, similar to basal **leaves;** basal leaves simple, cordate, ovate to deltoid, 1–5 cm broad, with entire to crenate margins; **petioles** 1–15 cm long with sheathing **stipular** bases, often bearing dark, fusiform **bulbils** ca 3 mm long, 1.5 mm broad in the **leaf axils; stems** somewhat succulent, erect or reclining, up to 20 cm long, not rooting at **nodes; roots** of 2 kinds, fibrous and tuberous, the latter fusiform or clavate, up to 5 mm thick. (2n = 16, 24, 32)

Infraspecific Variation: While much variability is evident in Europe, ours are the largely vegetatively reproducing, tetraploid variety *bulbifera.* Pollen is not markedly abortive, but the contents do not stain in aceto-carmine, indicating sterility.

Importance: This species is becoming more and more widespread in wet places, and has become a noxious weed where it crowds out native aquatic vegetation. Like other *Ranunculus* species, it may be poisonous to humans or livestock.





5. *Ranunculus cymbalaria* Pursh

Common Name: Seaside Crowfoot or Buttercup

Type Description: Pursh, Fl. Amer. Sept., vol. 2, p. 392, 1814

Synonyms: *Halerpestes cymbalaria* (Pursh) Greene, *Ranunculus nana* Fisch., *R. saxifragaefolius* Stephen ex Steud., *Oxygraphis cymbalaria* (Pursh) Prantl, *Cyrtorhyncha cymbalaria* (Pursh) Britt., *R. cymbalaria* var. *americana* DC., *R. cymbalaria* forma *hebecaulis* Fern.

Origin: Uncertain, boreal and subarctic

Habitats: Salt marshes, brackish mudflats, shallows and ditches

Habit: Low growing, stoloniferous, palustrine perennials

Flowering: June–August

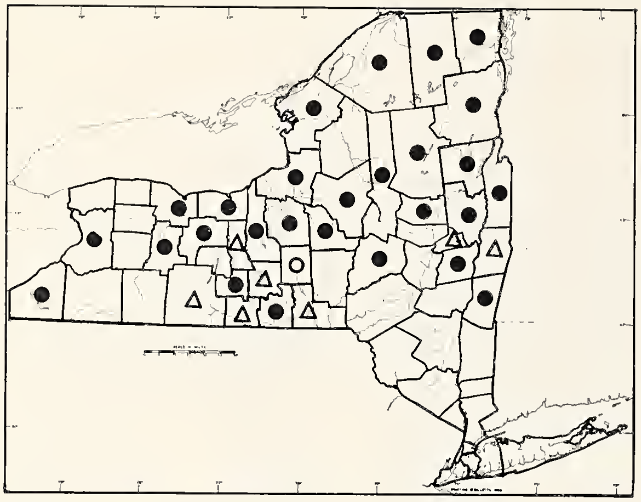
Fruiting: June–August

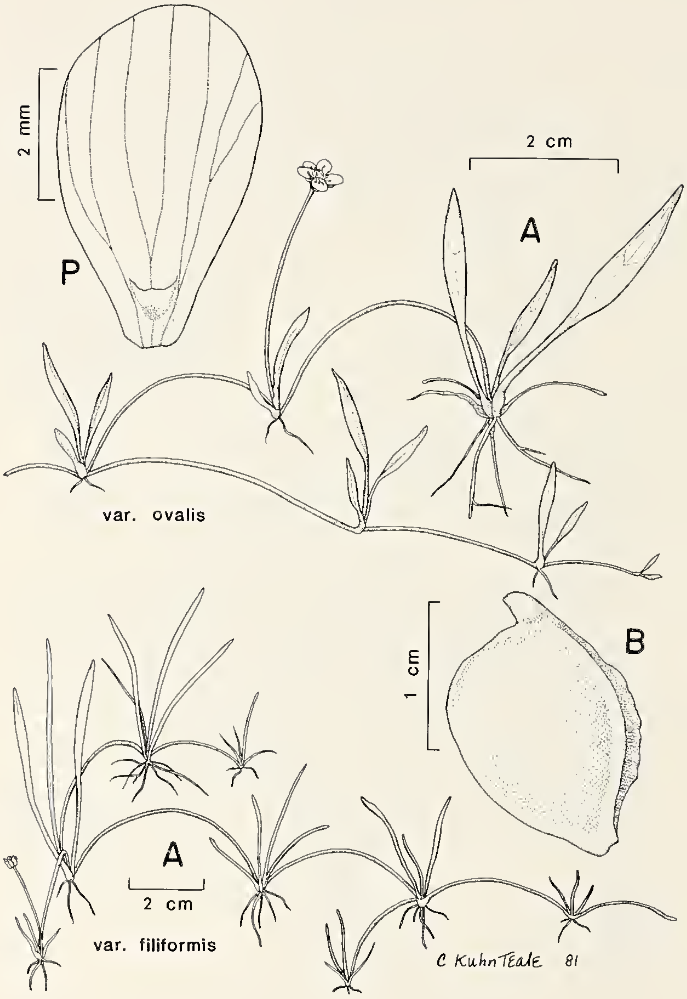
General Distribution: Newfoundland to New Jersey and Minnesota; widespread in western North America (var. *saximontana* Fern.) and also found in South America and Asia; introduced in Europe.

Description: Plants with **bisexual** flowers; **stigma** one per ovary, minute, apical; **style** 1 per ovary, ca 1 mm long, adaxially oriented, persistent; **ovaries** numerous (up to 200), clustered on a sparsely pubescent, cylindrical **receptacle**, becoming a cylindric **head of achenes** up to 13 mm long; **achenes** flattened, with chartaceous **pericarps**, 1.5–2 mm long, obovate to oblong, each face with ± 4 branching veins; **persistent style** (**beak**) eccentric, triangular, 0.25–0.50 mm long, straight or adaxially curved; **seed** often visible, ovoid, ca 0.5 mm long; **stamens** 10–30, about 2 mm long; **anthers** ovate to elliptic; **filaments** slender; **petals** 5 (6–12), yellow, 3–8 mm lng, 1–4 mm wide, obovate to oblanceolate, cuneate or clawed at base, each petal with a pocket-like **nectary scale** near the base; nectary scale with adnate lateral margins and a shallowly to deeply obcordate apex; **sepals** 5, greenish-yellow, cucullate, ovate to elliptic, (2) 3–5 mm long, spreading, deciduous; **inflorescence** irregularly cymose or scapose, of 1–6 flowers which are solitary on elongating **pedicels**; pedicels 0.5–3.0 cm long in flower, up to 6 cm long in fruit, sparsely pubescent, striate, subtended by narrowly oblong **leaves; basal leaves** 4–20 mm long, 4–14 mm wide, ovate to reniform with crenate margins and cordate to truncate bases (**first leaves** at each node often merely 3-lobed as in the northern var. *alpina* Hook.); **petioles** slender, up to 8 cm long in basal leaves, with **stipular bases**; **stems** 1–several, some scapose and erect, 2–15 (30) cm tall, others repent and rooting at **nodes**; **roots** slender, fibrous. (2n = 16)

Infraspecific Variation: Plants transitional to the diminutive var. *alpina* occur in New York State.

Importance: *Ranunculus* species are reported to be poisonous.





6. *Ranunculus reptans* L.

Common Names: Creeping Spearwort, Lesser Spearwort

Type Description: Linnaeus, Species Pl., p. 548, 1753

Synonyms: *Ranunculus flammula* L., *R. filiformis* Michx., *R. flammula* var. *reptans* (L.) Reich., *R. flammula* ssp. *reptans* (L.) Syme, *R. flammula* var. *intermedius* Hooker, *R. reptans* var. *intermedius* (Hook.) T. & G., *R. filiformis* var. *ovalis* Bigel., *R. flammula* var. *ovalis* (Bigel.) Bens., *R. intermedia* Heller, *R. flammula* var. *filiformis* (Michx.) Hook.

Origin: Circumpolar (uncertain)

Habitats: Shores and shallow, fresh water

Habit: Low growing, often stoloniferous perennials

Flowering: June–September

Fruiting: July–October

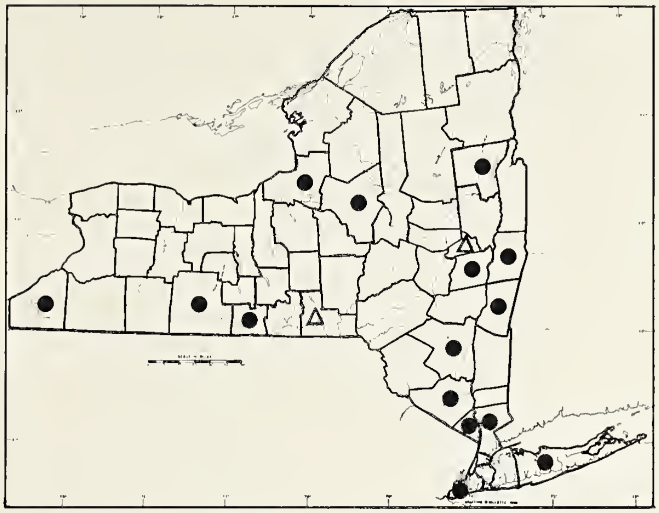
General Distribution: Northern Europe and boreal North America

Description: Plants with **bisexual** flowers; **stigma** 1 per ovary, linear-diffuse, minutely hairy, each covering the upper surface of a truncate style; **ovaries** 5–25 (50) clustered on a glabrous, granular, ovoid to ellipsoid **receptacle,** becoming a hemispheric, capitate **cluster of achenes**; **achenes** obovate, biconvex, 1–2 (−5) mm long, essentially glabrous, smooth or finely reticulate, margined; **persistent style (beak)** 0.1–0.3 (−1.0) mm long, slightly curved; **stamens** 10–25) (−50), 1–2 mm long; **anthers** elliptic, ca 0.75 mm long; **filaments** slender; **petals** 5 (−11), yellow, glabrous, obovate to oblong, cuneate at base, (2) 4–5 (−8) mm long, 1.5–4.0 (5) mm wide, deciduous, with basal **nectary scales**; nectary scale small, glabrous, pocket-like, wider than long, adnate along lateral margins; **sepals** 5, greenish-yellow, ovate-cucullate, 2–3 (5) mm long, strigose, deciduous; **flowers solitary** or weakly corymbose; **pedicels** 2–10 cm long, sparsely strigose to glabrescent; leaves disposed primarily in fascicles of 1–3 (or more), narrowly linear to oblanceolate, elliptic or obovate 0.5–20 mm wide, 10–70 mm long, entire to serrulate, with short, somewhat sheathing **petioles,** or narrower leaves sessile, sheathing at base; **leaf fascicles** subtended by a ± triangular **sheath**; **stems** repeatedly arching, stoloniferous, rooting at the **nodes** with filiform **roots.** (2n = 32)

Infraspecific Variation: The following key accomodates the variation in New York State plants:

1. Basal leaves filiform, linear (cauline leaves may be expanded); achenes 5–15; stems rooting at nearly every node .... *R. reptans* var. *filiformis* (Michx.) DC.
1. Basal leaves with well developed blades; achenes 10–20 or more; stems rooting only at lower nodes........ ....*R. reptans* var. *ovalis* (Bigel.) Torrey

Importance: Ranunculus species are reported to be poisonous.



7. ***Ranunculus ambigens*** **S. Watson**

Common Names: Spearwort, American Spearwort, Water-plantain Spearwort

Type Description: S. Watson, Bibl. Ind. N. Amer. Bot., vol. 1, p. 16, 1879, (also described: Proc. Amer. Acad., vol. 14, p. 289, 1879)

Synonyms: *Ranunculus obtusiusculus* Raf., *R. flammula* var. *major* Hook., R. ambigens var. *obtusiusculus* (Raf.) Davis

Origin: Eastern North America

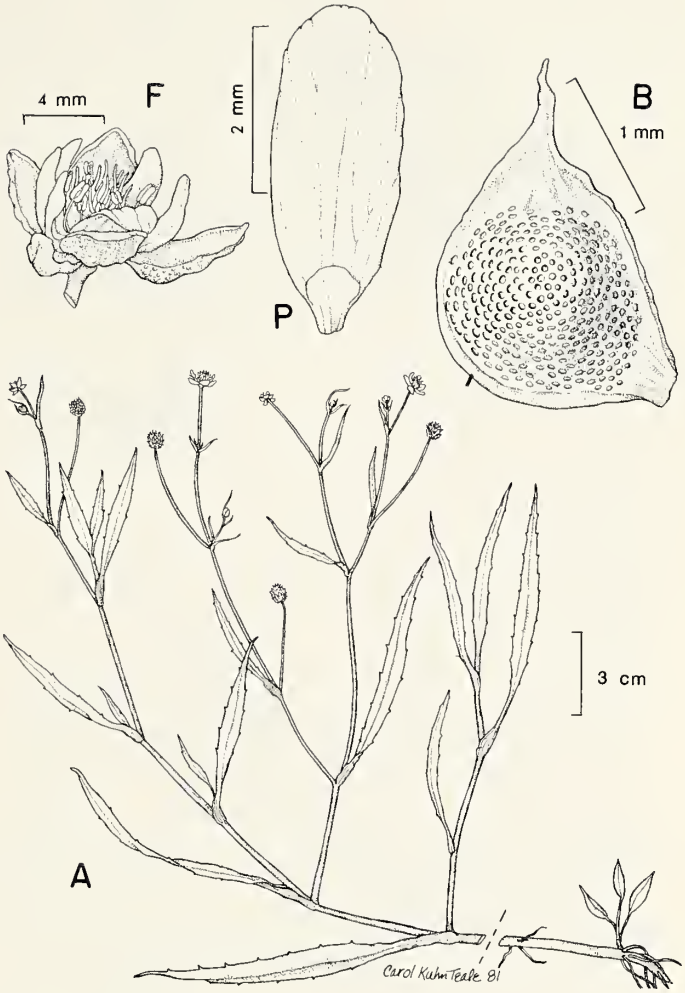
Habitats: Marshes, wet meadows, ditches, swamps, pond margins

Habit: Sprawling, clump-forming, palustrine to aquatic perennials

Flowering: June–August

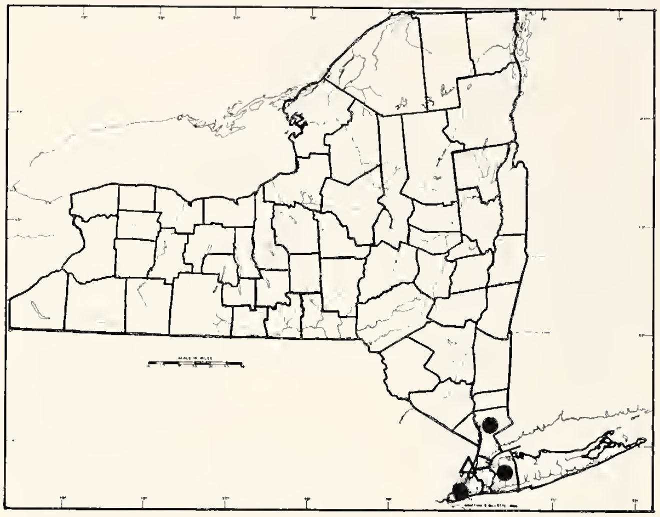
Fruiting: July–August

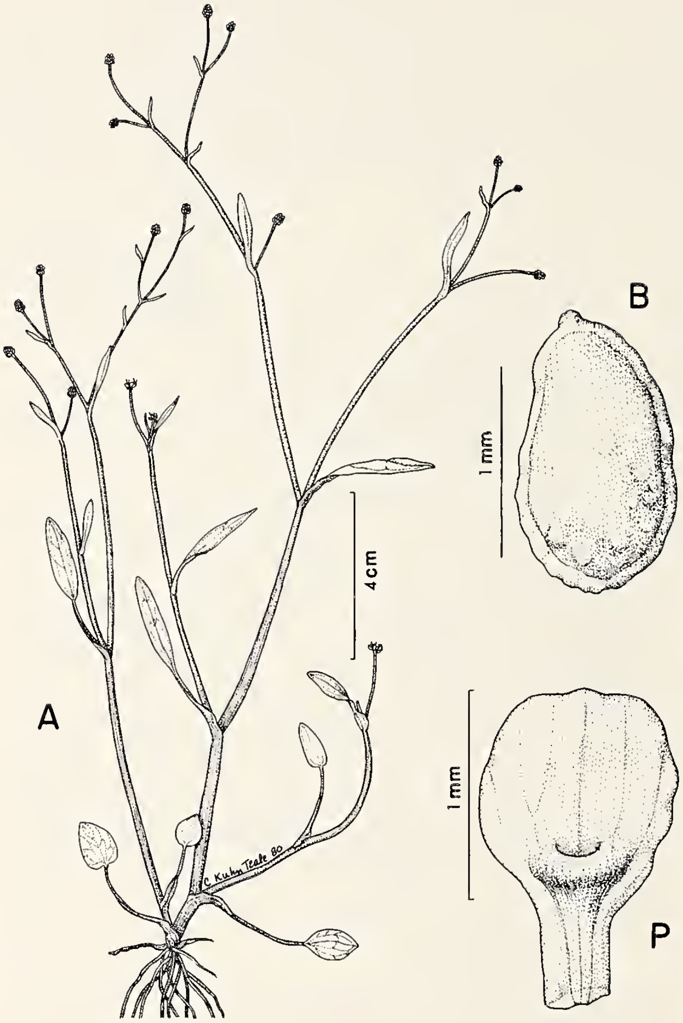
General Distribution: Maine to Virginia (Georgia) and Louisiana, west to Minnesota



Description: Plants with **bisexual** flowers; **stigma** one per ovary, minute, apical; **style** 1 per ovary, ca 1 mm long, prominent, at a right angle to the ovary, the lower margin thin, the upper margin corky, thickened, the **corky zone** extending down the adaxial margin of the ovary; **ovaries** 30–50 (−90) ca 1 mm long, spirally arranged on a sparsely hispid, narrowly obovate to cylindric **receptacle,** becoming an ovoid **head of achenes** 3–6 mm long; **achenes** obovate-cuneate, ca 2 mm long, weakly biconvex, narrowly to broadly margined, the surfaces spongy-reticulate, glabrous; **persistent style (beak)** horizontally oriented, T-shaped in x-section, ca 1 mm long; **stamens** 30–50, ca 2 mm long; **anthers** short-elliptic; **filaments** slender; **petals** 5–6, yellow, ovate to oblanceolate, glabrous, 4–8 mm long, 1.5–3 mm wide, each petal with a basal **nectary gland** and an associated scale; **nectary scale** variable: apically rounded and laterally free or somewhat reduced, apically retuse and laterally mostly fused; **sepals,** 5, yellowish to whitish-green, orbicular-cucullate to ovate, glabrous, ca 4 mm long, 1.5–3 mm wide, deciduous, spreading or tardily reflexed; **flowers solitary** on pedicels in an irregularly cymose **inflorescence**; **pedicels** elongating primarily in bud and flowering stages, 0.5–5 cm long, glabrous, subtended by **reduced leaves**; **leaves** all cauline, lanceolate, 2–12 cm long, 4–30 mm wide, sparsely villous below, minutely serrate, the serrations tipped with **hydathodes**; **petioles** up to 6 cm long, glabrous; **stipular leaf bases** sheathing, up to 2 cm long, often with a few marginal hairs, tapering or auricled; **vegetative stems** up to 2 cm thick, decumbent-stoloniferous, branching and mat-forming, rooting and sprouting at the **nodes**; **flowering stems** erect to ascending, up to 80 cm tall, fistulose, striate, succulent; **roots** mostly adventitious, up to 1 mm thick with slender, fibrous branches.

Importance: *Ranunculus* species are reported to be poisonous.





8. ***Ranunculus pusillus*** **Poir. ex Lam.**

Common Name: Spearwort

Type Description: Poiret in Lamarck, Encycl. Meth. vol. 6, p. 99, 1804

Synonyms: *Ranunculus humilis* Pers., *R. oblongifolius* Ell., *R. boiletti* Greene, *R. trachyspermus* Engelm. (in part), *R. pusillus:* (var. *muticus* T. & G., var. *oblongifolius* T. & G., and var. *lindheimeri* Gray)

Origin: North America

Habitats: Swamps, shallow water, seepage areas, seasonally damp soil

Habit: Erect or decumbent, herbaceous annuals

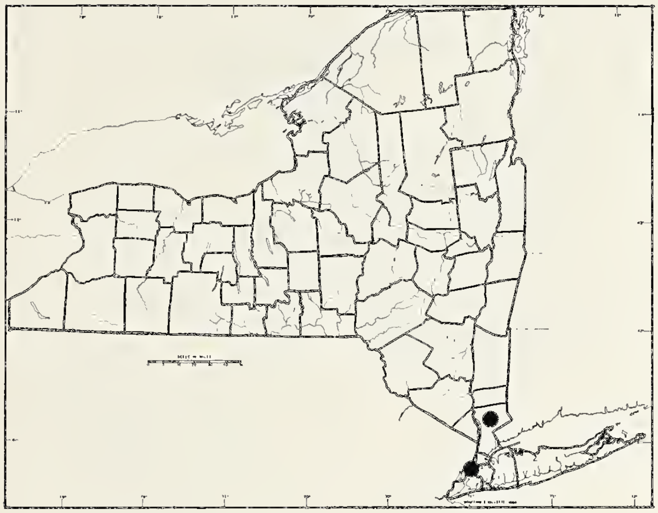
Flowering: April–May

Fruiting: May–June

General Distribution: New York to Florida, west to Indiana and Missouri, (disjunct to California)

Description: Plants with **bisexual** flowers; **stigma** one per ovary, minute, apical; **style** one per ovary, about 1 mm long; **ovaries** 15–50, on a spherical to cylindric or pear-shaped, granular, glabrous **receptacle,** becoming a capitate or hemispheric **head of achenes** ca 4 mm long; **achenes** plump, obovate in outline, ca 1 mm long, slightly margined, faces smooth (to papillate), achene slightly **beaked** with an 0.1–0.2 mm **persistent style**; **stamens** 5–10, ca 1.5 mm long; **anthers** elliptic; **filaments** slender; **petals** 1–3, yellow, obovate, 1–1.5 mm long, with a small **nectary scale** at the base; **nectary scale** pocket-like, ca 0.2 mm long, the apex truncate or emarginate; **sepals** 5, ovate, not reflexed, deciduous, greenish yellow to whitish equaling or slightly exceeding the petals, glabrous or with a few scattered hairs, 1–2 mm long, 0.8–1.0 mm wide; **inflorescence** obscurely cymose, each **flowers** solitary on an elongating **pedicel**; pedicel 1–15 mm long in flower, up to 6 cm long in fruit, subtended by a linear to lanceolate (oblanceolate) **bract**; bracts barely petiolate with dilated, ciliate, stipule-like bases; **upper cauline leaves** similar to bracts, but larger and more prominently petiolate, their margins occasionally showing dentations; **lower cauline** and **basal leaves** simple, ovate to oblong, up to 5 cm long, 1.7 cm wide, margin sometimes shallowly dentate, apex acute to rounded, the base rounded to subcordate; **petioles** 1–6 cm long excluding the **stipular** bases (up to 1 cm long) which are sheathing and sometimes hairy; **stems** multiple, from the base, hollow, somewhat succulent, freely branching above, erect or decumbent, sometimes adventitiously rooting at **lower nodes**; **roots** filiform.

Importance: *Ranunculus* species are reported to be poisonous.



9. *Ranunculus parviflorus* L.

Common Name: Small-flowered Crowfoot

Type Description: Linnaeus, Species Pl., ed. 2, vol. 1, p. 780, 1762

Synonyms: *Ranunculus trachysperma* Ell., *R. parviflorus* var. *dimidiatus* Krause

Origin: Mediterranian Europe

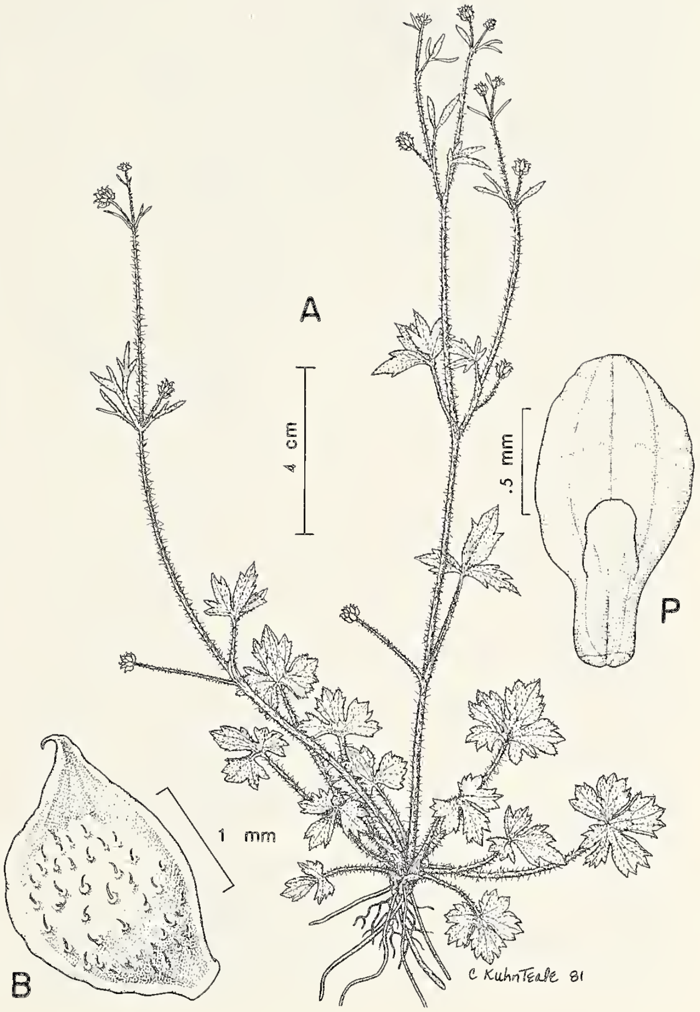
Habitats: Waste ground, disturbed, often moist soil

Habit: Rosette-forming, terrestrial, winter annuals

Flowering: April–May

Fruiting: April–May (June)

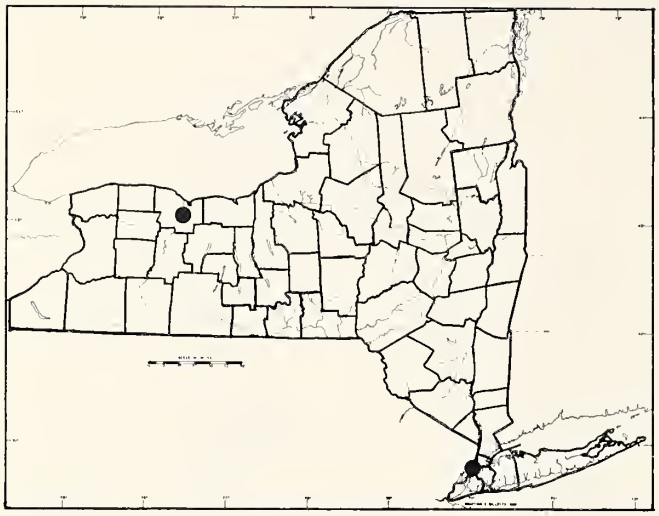
General Distribution: European introduction, usually persisting only in Mediterranian or other warm climates (s. e. United States, California, New Zealand etc.)

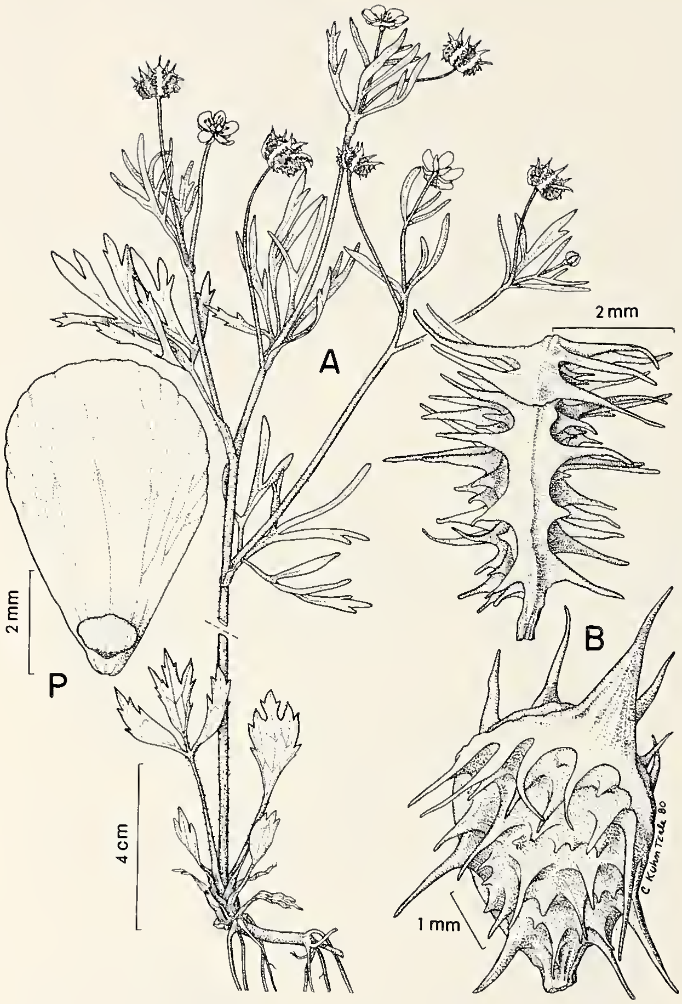


Description: Plants with **bisexual** flowers; **stigma** 1 per ovary, apical or linear on the terminal adaxial portion of the striaght or recurved, pellucid apex of the conical **style**; style 1 per ovary, ca 0.5 mm long; **ovaries** (5–) 9–15 (–18), clustered on a glabrous but granular **receptacle** ca 1 mm long which expands little in fruit, becoming a capitate **head of achenes**; **achenes** flattened, obovate in outline, ca 1.5 mm long, 1 mm wide, margins greenish, faces brownish to pale tan, papillate, the papillae often reddish, bearing curved or hooked, bristle-like hairs; **persistent style (beak)** deltoid, outwardly curving, ca 0.5 mm long; **stamens** usually 4–6 (1–8) ca 2 mm long; **anthers** elliptic; **filaments** slender; **petals** (0–) 2–3 (–5), glossy yellow, clawed at bases, oval or elliptic (occasionally lobed at apex) usually 3–4 mm long, ca 2 mm wide, each bearing an ovate or obcordate **nectary scale** at the summit of the **claw**; **sepals** 5, greenish-yellow, usually narrowly elliptic or narrowly ovate (sometimes green, leaf-like, lobed or with sheathing bases) not reflexed, densely pubescent, equaling the petals in size; **flowers** axillary, each on an elongating **pedicel**; pedicels 0.1–2 cm long in flower to 5 cm in fruit, densely pubescent; **bracts** usually lanceolate, petioled, 8–15 mm long, occasionally ternate; **cauline leaves** ternate with linear segments or smaller, but similar to the **basal leaves**; basal leaves in a rosette, simple, reniform, 15–20 mm long, 20–25 mm wide, shallowly or deeply 3-lobed, pubescent, margins crenate to acutely toothed; **petioles** 2–12 cm long, pubescent, with expanded, stipule-like bases; **stems** up to 30 cm tall, branched, erect or decumbent (not rooting at nodes); **roots** slender, fibrous.

Note: This species is not likely to persist in New York State. Reports of its occurrence are undoubtedly due to repeated introductions.

Importance: *Ranunculus* species are reported to be poisonous.





10. Ranunculus arvensis L.

Common Names: Corn Crowfoot, Hungerweed, Devil's-claws

Type Description: Linnaeus, Species Pl., p. 555, 1753

Origin: Western Europe

Habitats: Waste ground, roadsides, dry woodlands as an escape

Habit: Erect, terrestrial annuals (perennials?)

Flowering: April–May

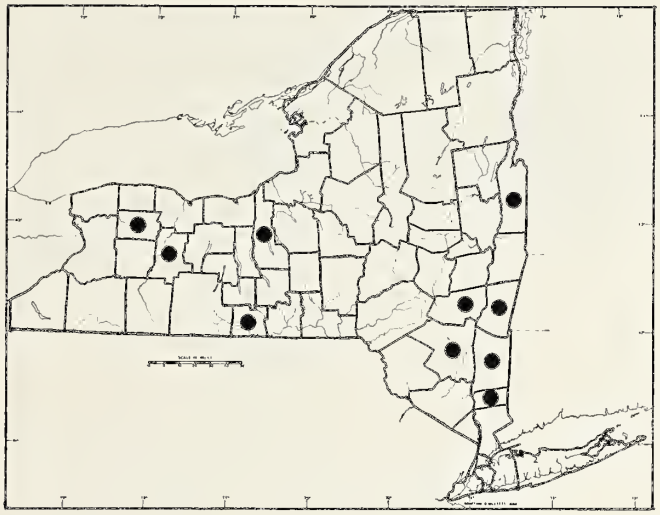
Fruiting: May–June

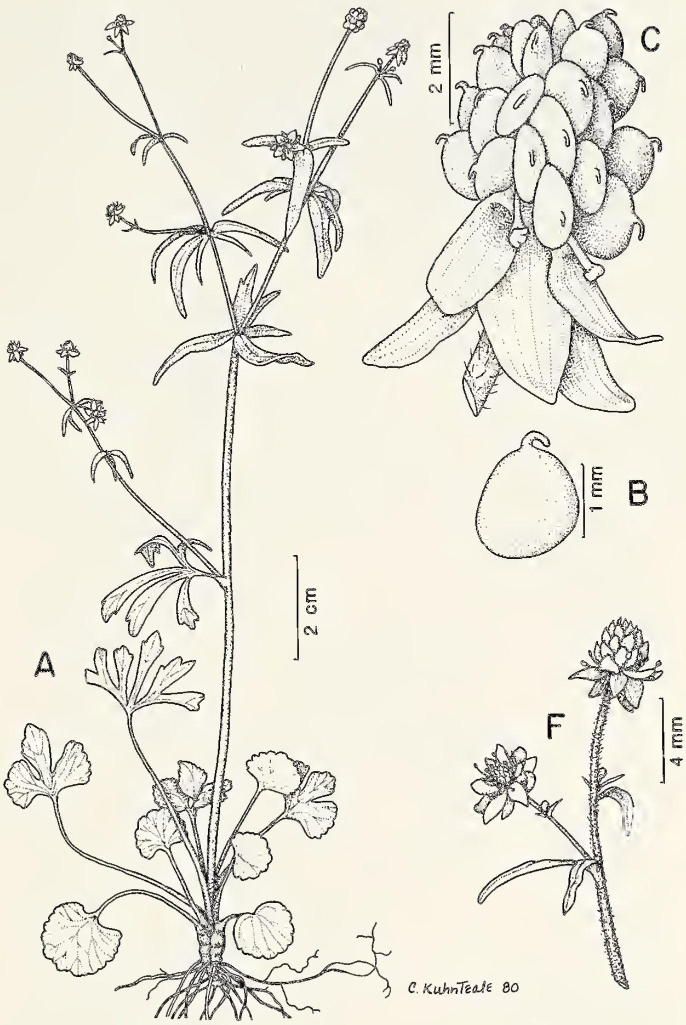
General Distribution: Widely scattered weed in the United States, native to western and central Europe

Description: Plants with **bisexual** flowers; **stigma** 1 per ovary, minute, pellucid, apical or narrowly linear on the abaxial tip of the **style;** style 1 per ovary, prominent, narrowly triangular, somewhat laterally compressed, ca 1.5 mm long; **ovaries** (0–) 3–8 (–16) on a short-conic to hemispheric **receptacle,** becoming a globose **head of achenes; achenes** obovate to ovate, flattened, ca 5 mm long (4.5–7.0 mm), conspicuously papillate-spiny, the **spines** stout, with deciduous (or fragile) hooked apices, achene margins rim-like, bearing spines, the achene base slightly stipitate; **persistent style (beak)** up to 2.5 mm long, straight, but abaxially eccentric; **stamens** (1–) 4–13 (–18), spiraling, ca 3.5 mm long; **anthers** elongate-elliptic; **filaments** linear; **petals** 0–8,usully 5, ovate to obovate, 4–8 mm long, 2–6 mm wide, yellow, deciduous, with a small, fan-like **nectary scale** at the base of each; **sepals** 0–9, usually 5, yellow-green, elliptic to lanceolate, 3–6 mm long, 1.3–3.5 mm wide, deciduous, pubescent, not reflexed; **flowers solitary** in the axils of cauline leaves; **pedicels** elongating in fruit up to 5 cm, pubescent; **cauline leaves** alternate, ternately or biternately compound, 1–5 cm wide, 1–4 cm long, the leaflets or divisions lanceolate to linear, entire below, often 3-toothed at summit; **basal leaves** simple and apically toothed or deeply 3-lobed with oblanceolate, apically toothed divisions, glabrous or pubescent; **petioles** sparsely pubescent, with somewhat expanded,sheating bases, (petioles) up to 5 cm long below, to almost absent on cauline leaves; **stems** more or less erect, usually not rooting at lower **nodes,** branched, up to 40 cm tall, arising from stout, fibrous **roots.**

Note: This species may not persist for significant periods in New York State.

Importance: *Ranunculus* species are reported to be poisonous.





11. Ranunculus allegheniensis Britt.

Common Names: Allegheny Crowfoot, "Smooth-leaved Crowfoot"

Type Description: Britton, Bull. Torrey Club, vol. 22, p. 234, 1895

Origin: Eastern North America

Habitats: Dry woods, rocky slopes and thickets

Habit: Erect, annual herb (short-lived perennial?)

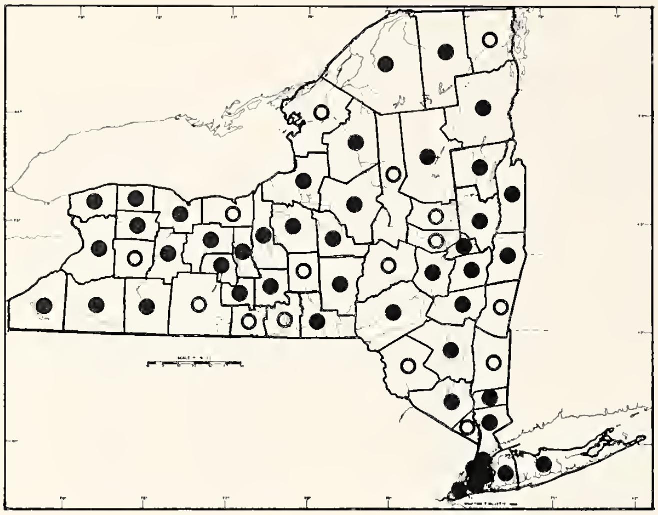
Flowering: May–June

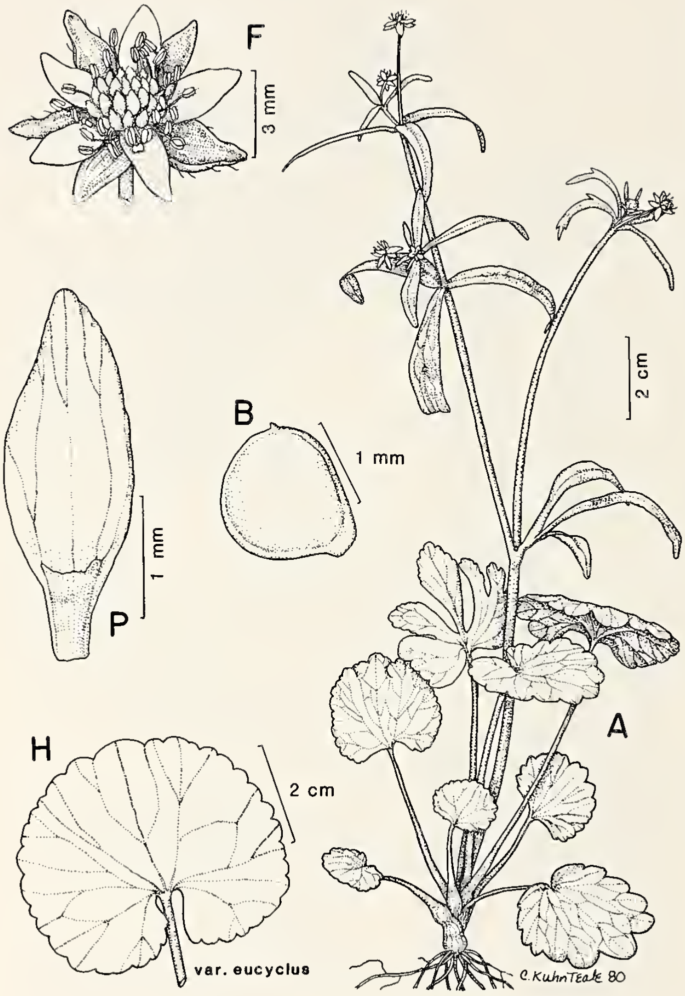
Fruiting: May–July

General Distribution: New England to North Carolina and Tennessee

Description: Plants with **bisexual** flowers; **stigma** 1 per ovary minute, apical; **style** one per ovary, long-tapering, persistent in fruit, about 0.8 mm long and abaxially recurved; **ovaries** up to 50, clustered on a fusiform to narrowly elliptic, sparsely pubescent **receptacle**, becoming a **head of achenes**, up to 4 mm long in fruit; **achenes** orbicular to obovate, biconvex, 1.4–2.0 mm long, weakly margined, with smooth (not shiny) surfaces, **beaked** with the abaxially positioned and strongly abaxially curved **persistent style**, 0.6–1.0 mm long; **stamens** 10–25, hypogynous; **filaments** slender, 1.0–1.3 mm long; **anthers** elliptic, 0.5 mm long, **petals** 5, yellow, deciduous, narrowly obovate, 0.7–1.5 mm long, apex acute glabrous, with a **nectary scale** at base; nectary scale obtriangular with a rounded, often recurved apical lobe, **lateral margins** free or fused; **sepals** 5, ovate, more than twice as long as the petals, 2.0–3.5 mm long, cucullate, greenish-yellow, with pale borders, deciduous, reflexed, pubescent; **flowers** solitary on elongating pedicels in an obscurely cymose **inflorescence**; **pedicels** often striate, glabrescent, 1–15 mm long in flower, up to 10 cm long in fruit, each subtended by a 3–5 parted, usually sessile,**bracteal leaf** with lanceolate lobes; **cauline leaves** similar to bracts, but usually larger and more petiolate, glabrous or very sparsely pubescent, dichotomously cut and lobed; **basal leaves** mostly simple and reniform in outline, but not uncommonly cut and lobed, and transitional to cauline leaves, margins often crenate, bases shallowly cordate, somewhat succulent, petioled; **petioles** up to 10 cm long on basal leaves, glabrescent or pubescent on the veins of the **sheathing leaf bases**; **stems** 1–several, branched, striate, somewhat succulent, hollow, up to 7 dm tall, essentially glabrous and glaucous, from a slender **rootstock**.

Importance: *Ranunculus* species are reported to be poisonous.





12. Ranunculus abortivus L.

Common Names: Kidney-leaved Crowfoot, Smooth-leaved Crowfoot, Chicken-pepper, Small-flowered Crowfoot or Buttercup

Type Description: Linnaeus, Species Pl., p. 551, 1753

Synonyms: *Ranunculus nitidus* Walt., *R. ruderalis* Greene, *R. holmei* Greene, *R. michiganensis* Farw., *R. abortivus* var. *nitidus* (Walt.) D.Don, *R. abortivus* var. *sylvaticus* Laws.

Origin: North America

Habitats: Damp woods, streamsides, partial clearings

Habit: Erect, annual herbs, probably perennial in var. *eucyclus*

Flowering: (April) May–June

Fruiting: May–July

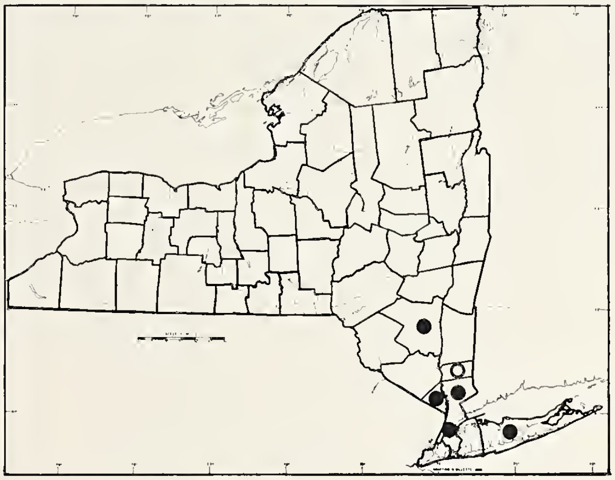
General Distribution: Labrador to Alaska, Washington state, south to Texas and Florida

Description: Plants with **bisexual** flowers: **stigma** 1 per ovary minute, apical; **style** one per ovary, triangular, 0.1–0.25 mm long, persistent in fruit; **ovaries** up to 50, clustered on a fusiform to narrowly elliptic, sparsely pubescent **receptacle,** becoming an ovoid **head of achenes** up to 4 mm long in fruit; **achenes** orbicular to obovate, biconvex, (1) 1.3–1.5 mm long, weakly margined, with smooth (not shiny) surfaces, beaked with a straight or curved, eccentrically positioned; **persistent style** 0.1–0.25 mm long; **stamens** 15–30; **anthers** elliptic, about 0.5 mm long; **petals** 5, yellow, dull to glossy, narrowly obovate, 1.5–2.0 (3.5) mm long, glabrous, apex acute or blunt, with a pocket-like **nectary scale** at the petal base; nectary scale obtriangular with a truncate or emarginate apex and adnate lateral margins; **sepals** 5, ovate, cucullate, up to twice as long as the petals, 2–3 (4) mm long, greenish-yellow or purplish-tinged with pale borders, deciduous, tardily reflexed, pubescent; **flowers solitary** on elongating pedicels in an obscurely cymose **inflorescence; pedicels** weakly striate, pubescent or glabrous, 1–15 mm long in flower, up to 10 cm in fruit, subtended by simple and lanceolate or 3–5 parted, sessile or short-petioled **bracteal leaves; lobes,** when present, oblong to lanceolate; **cauline leaves** with linear, dichotomously branching lobes (pseudo-palmate), glabrescent, sessile to short-petioled; **basal leaves** usually simple (or 3-lobed and transitional), glabrescent, reniform to ovoid, 1–7.5 (9) cm in diameter, often slightly succulent, shallowly to deeply cordate at base, margins crenate with the lower margins of the crenations often overlapping; **petioles** (of basal leaves) up to 1 cm long, glabrous or puberulent, with scarious **stipular leaf bases; stems** 1–several, branched, striate, somewhat succulent, hollow, up to 8.5 dm tall, pubescent or glabrous, green; **roots** fibrous, filiform.

Infraspecific Variation: Fernald described variety *eucyclus* with large, markedly circular basal leaves, narrow basal sinuses and slender flexuous stems. Field observations indicate that this variety is probably perennial. Benson's

(1948) circumscription of its distribution was: Quebec to Newfoundland, south to New York State and New England. Fassett (1942) rejected the variety after mass-collection study, but few of his collections were within the range of the variety. We tentatively accept the variety *eucyclus* Fern. until further studies are made. Variety *acrolasius* Fern. includes plants with pubescent upper stems and petioles. This taxon is weak, based on a single character often subject to environmental modification in this genus. Pubescent plants are found mostly in the northern part of the species-range.

Importance: *Ranunculus* species are reported to be poisonous.



13. Ranunculus micranthus Nutt. ex T. & G.

Common Name: Small-flowered Crowfoot

Type Description: Nuttall in Torrey & Gray, Fl. N. Am. 1: 18, 1838

Synonyms: *Ranunculus cymbalistes* Greene, *R. delitescens* Greene, *R. abortivus* L. var. *micranthus* (Nutt.) Gray, *R. micranthus* var. *cymbalistes* (Greene) Fern.

Origin: Eastern North America

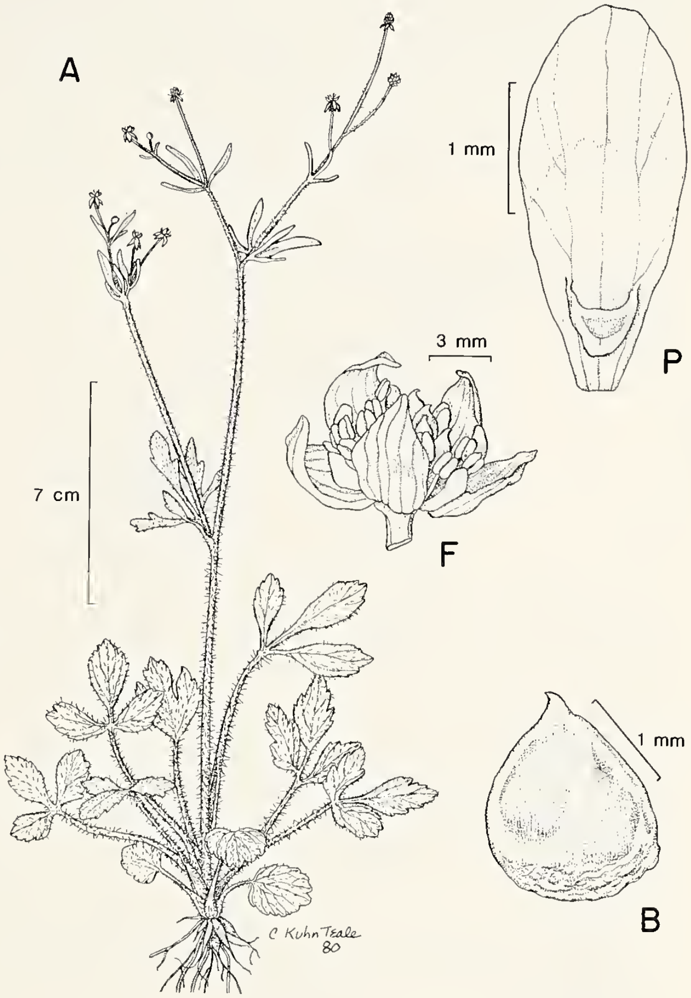
Habitats: Rich woods, rocky, shaded areas, especially slopes

Habit: Erect, terrestrial perennials

Flowering: May

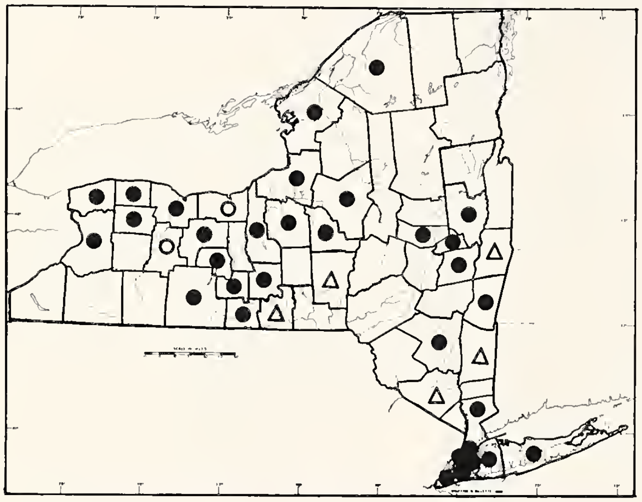
Fruiting: May–June

General Distribution: Massachusetts to North Carolina, west to Oklahoma and South Dakota



Description: Plants with **bisexual** flowers; **stigma** one per ovary, minute, apical; **style** one per ovary, short, pellucid, usually recurved, persistent in fruit; **ovaries** up to 50, clustered on a slender, fusiform **receptacle** which is glabrous (or pubescent only near apex), becoming an ovoid or cylindroid **head of achenes** 3–6 mm long and 2–4 mm wide; **achenes** orbicular to obovate, biconvex, 1.25–1.5 mm long, weakly margined, surface minutely pitted, essentially smooth, each **beaked** with 0.15–0.3 mm long, curved and often hyaline, eccentricly positioned **persistent style; stamens** 15–30, ca 2 mm long; **anthers** elliptic; **petals** 5, yellow, elliptic to obovate, 2–3 (3.5) mm long, 1.0–2.5 mm wide, glabrous, each with a pocket-like **nectary scale** at base; nectary scale obtriangular, with a retuse or obcordate apex; **sepals** 5, yellowish-green to whitish-green, 2.5–3.5 mm long, ovate, reflexed, deciduous, up to 1.5 times as long as the petals, pubescent; **flowers solitary** on elongating pedicels in an obscurely corymbose **inflorescence; pedicels** 2–20 mm long in flower, 15–50 (90) mm long in fruit, sparsely pubescent (to glabrous); **subtending leaves** sessile or short-petioled, simple and linear to narrowly obovate or 3–5 cleft or forked, with linear to narrowly obovate lobes; **cauline leaves** 3–5 cleft, short-petioled, villous, their lobes oblanceolate to

obovate, often twice lobed; basal **leaves** villous, often dimorphic, the simple ones 1–3 cm broad, ovate to nearly circular in outline, bases truncate to cuneate, margins crenate or crenate-lobed and transitional to the compound type of basal leaf; compound basal leaves ternate, usually with stalked, obovate to oblanceolate leaflets which are often apically crenate or lobed, their bases usually cuneate; **petioles** villous, 3–8 cm long on basal leaves with expanded **stipular bases; stems** 1 (−8), branched, striate, flexuous (to somewhat succulent), often fistulose, 15–30 (40) cm tall, villous even towards the base; **roots** dimorphic, filiform and fibrous as well as fusiform-thickened.
Infraspecific Variation: In one specimen observed, the nectary scale was associated with an apically rounded, laterally free, petal-like structure ca 1 mm long (perhaps teratological). Fernald (1950) refers northeastern materials to var. *delitescens* (Greene) Fern., a taxonomically doubtful entity.
Importance: *Ranunculus* species are reported to be poisonous.



14. *Ranunculus sceleratus* L. ssp. *sceleratus*

Common Names: Cursed Crowfoot, Celery-leaved Crowfoot, Blisterwort, Ditch Crowfoot

Type Description: Linnaeus, Species Pl., p. 551, 1753

Synonyms: *Ranunculus sceleratus* forma *natans* Gluck; many additional synonyms apply only to the western *R. sceleratus* ssp. *multifidus* (Nutt.) Hultén, which is apparently native North American

Origin: Eurasia

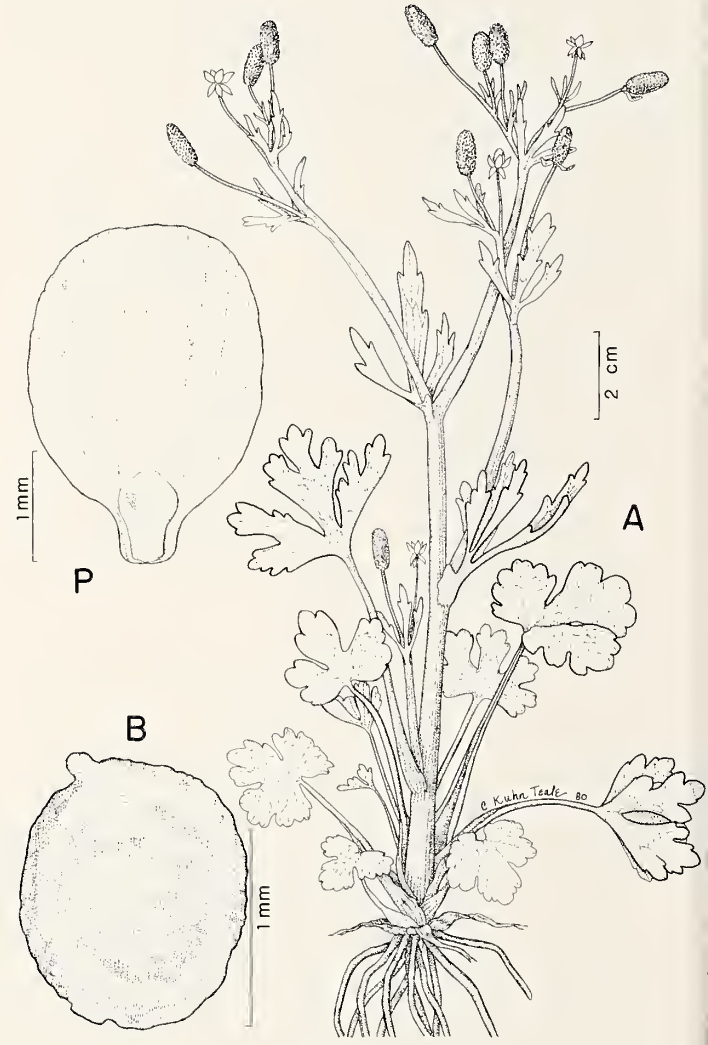
Habitats: Wet soil or shallow water in ditches, swamps, wet woods, on shores and rarely in salt marshes

Habit: Erect, somewhat succulent annuals

Flowering: May–July (rarely later)

Fruiting: May–August (–October)

General Distribution: Circumboreal, Eurasia to western and central North America; most authorities consider ssp. *sceleratus* of eastern North America to have been introduced from Europe

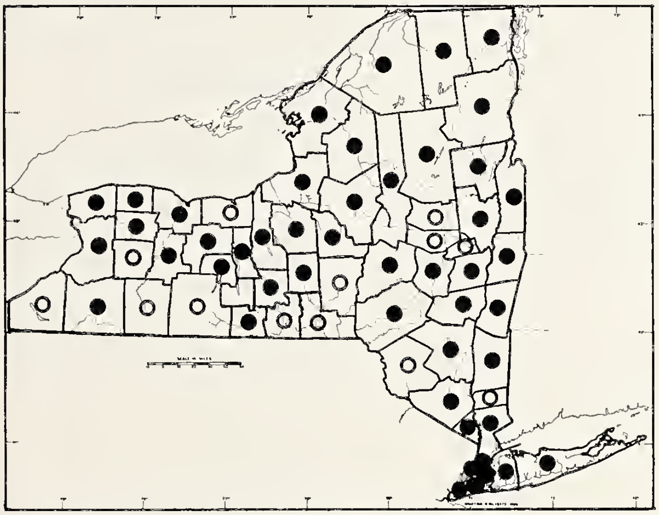


Description: Plants with **bisexual** flowers; **stigma** 1 per ovary, minute; **style** 1 per ovary, straight or recurved, eccentric-apical, ca 0.1 mm long; **ovaries** (50–) 100–300, clustered on a glabrous to pilulose, elliptic to cylindric **receptacle,** becoming a cylindric **head of achenes** 2.5–10 mm long, 3–7 mm thick; **achenes** glabrous, suborbicular to obovate, 0.8–1.4 mm long, minutely **beaked** by the **persistent style,** achenes with corky-pustulose margins and obscurely transversely reticulate central areas; **stamens** 10–25, ca 1.5 mm long; **anthers** short-elliptic; **filaments**

linear; **petals** 5, light yellow, 2–5 mm long, 1.5–3 mm wide, oblong to obovate, often pilose beneath, each with a notched, marginally adnate **nectary scale** ca 1 mm long at its base; **sepals** 5, yellowish to green, spreading, reflexed, or often promptly deciduous, pilose, 2–5 mm long, 1.5–2 mm wide; **peduncles** pilose, 0.5–3.0 cm long, each one bearing a single flower; **upper leaves** subtending peduncles, sessile, oblanceolate to elliptic and entire or resembling cauline leaves just below; **cauline leaves** numerous, somewhat succulent, variable in shape, dissection and petiole length, the upper ones tending to be elliptic or oblanceolate, entire or with rounded, irregular lobing and cuneate bases; **lower cauline leaves** tending to be reniform, but often ternately cleft or lobed, the lobes generally obovate with rounded sinuses and obtuse tips, the larger leaves up to 5 cm long, 6 cm broad; **basal leaves** more or less reniform in outline 0.8–10 cm wide, often with shallow to deep, rounded lobes (submerged plants may produce elongate floating leaves); **petioles** of basal leaves up to 25 cm long; **sheathing bases** 2–10 mm long with **hyaline auricles**; **stems** erect, hollow, often profusely branching, glabrous, slightly furrowed, leathery to somewhat succulent, especially if in contact with water, 1–10 dm tall from fleshy **roots**. (2n = 32)

Infraspecific Variation: Environmental modifications are common in this species, and heterophylly is the general rule. Dry site plants are often depauperate, while inundated plants may have strikingly inflated stems and floating leaves. The latter have been described as forma *natans* Glück.

Importance: *Ranunculus* species are reportedly poisonous.



15. *Ranunculus acris* L.

Common Names: Common Buttercup, Tall Buttercup, Field Buttercup, Goldiecup, Blister-weed

Type Description: Linnaeus, Species Pl. p. 554, 1753

Synonyms: *Ranunculus acer* L., *R. boreanus* Jordon (of N.Y. reports), *R. acris* var. *latisectus* G. Beck, *R. acris* var. *steveni* (And. ex Bess.) Lange

Origin: Europe

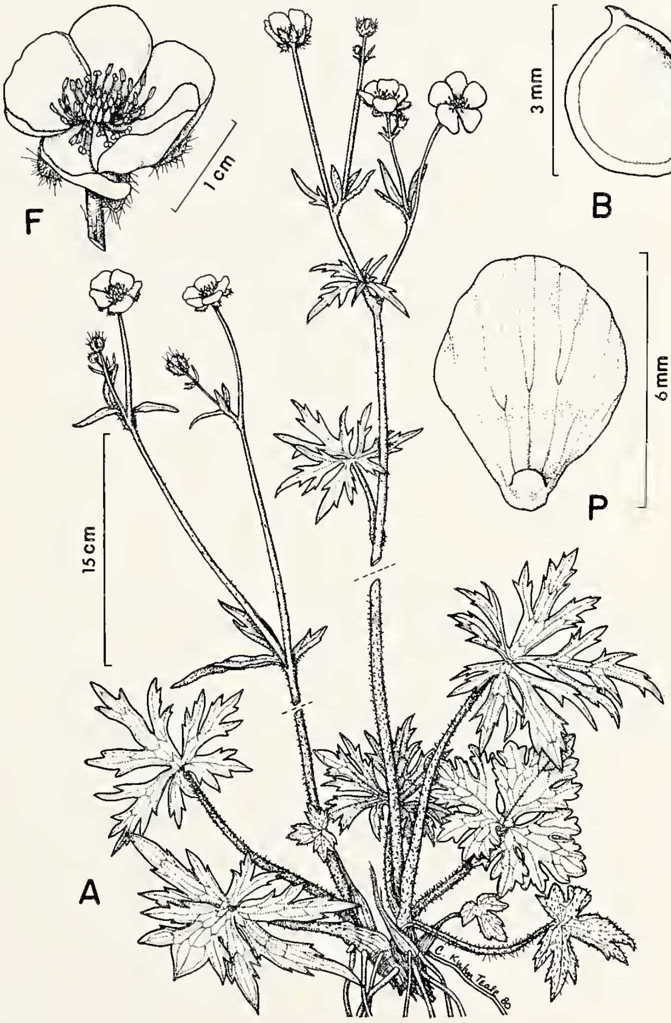
Habitats: Open, sunny places from sea level to alpine summits, typically pastures, meadows, fields, roadsides, lawns etc.

Habit: Erect (to spreading) herbaceous, terrestrial perennials

Flowering: May–Sept.

Fruiting: May–Sept. (October)

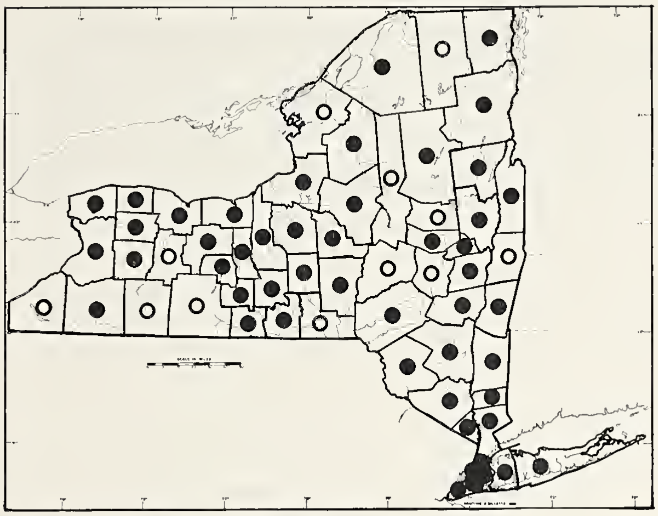
General Distribution: A common weed worldwide in boreal and temperate zones



Description: Plants usually with **bisexual** flowers; **stigma** 1 per ovary, diffuse and covering the upper surface of the recurved style, the **stigmatic surface** usually distinguishable in fruit; **style** 1 per ovary, short, apical, but adaxially eccentric and adaxially recurved, persistent in fruit; **ovaries** (14) 25–40 (–83), clustered on a glabrous, pear-shaped **receptacle,** becoming a globose **head of achenes** 4–7 mm long and 4–8 mm wide; **achenes** obliquely obovate, more or less flattened, 2–3 mm long, 1.8–2.5 mm wide, margined, surface dull and brown when ripe; **persistent style** (**beak**) outwardly curved, deltoid, 0.2–0.6 mm long; **stamens** 40–160, up to 4 mm long; **anthers** elliptic; **filaments** linear; **petals** 5 (–13), chrome yellow (to white), glossy, obovate, cuneate at base, 5–11 (–15) mm long, 4–10 (–14) mm wide, deciduous, each petal with a basal **nectary scale**; nectary scale obovate, ca 1 mm long, attached at its base and lower ¼ of sides; **sepals** 5 (–13), ovate, shorter than the petals, greenish, spreading, more or less adpressed to the petals (not reflexed), with long hairs on undersurfaces, deciduous; **flowers** solitary on elongating pedicels forming an obscurely cymose **inflorescence,** the early flowers usually larger; **pedicels** pubescent, 1–5 cm long in flower, 4–12 cm long in fruit; **subtending leaves** with linear lobes, ternate to 5 parted; other **cauline leaves** alternate, petioled, similar in form, but smaller than the leaves of the **basal rosette**; **basal leaves** usually pentagonal in outline, palmately cleft with (2) 3 (–7) short-petiolate or sessile major divisions, the terminal division usually ternately or biternately lobed and toothed, lateral divisions primarily 2-lobed with 2- or 3-cut tertiary lobes; lobes are cuneate at base; **leaves** generally 4–8 cm long, 5–10 cm wide, densely pubescent with appressed hairs on lower surfaces, less hairy above; **petioles** (0.1) 5–20 cm long, varying from densely pubescent to glabrous, bases of petioles sheathing, 3–5 cm long; **stems** 1–several, erect, freely branching above the lower ⅓ of plant, fistulose towards the base, pubescent, 15–110 cm tall, arising from an erect (to creeping) sympodial, dark brown to black **rhizome**; rhizome more or less persistent, but usually shortened by rotting and shrouded with persistent fibers from leaf bases of previous years; **roots** tough, fibrous. (2n = 14, 28, 29, 32 and 18 in gynodioecious plants)

Infraspecific Variation: Several subspecies are recognized in Europe, based on characters of the rhizome, leaf dissection, hairs and phyllotaxis (see S. M. Coles, *Watsonia* 8: 237–261). New York specimens with elongate rhizomes and less dissected, wide-segmented leaves have the spiral phyllotaxis of ssp. *acris* rather than the distichous type of ssp. *friesianus* (Jord.) Rouy & Fouc. Plants previously reported as var. *steveni* (And. ex Bess.) Lange and var. *latisectus* G. Beck may be referred to *R. acris* ssp. *acris* var. *villosus* (Drab.) S. M. Cole, The common cultivar "Flore Pleno" has twice been encountered as in a non-garden situation in New York State. Abberent individuals may be found with hairs on petals or fruits.

Importance: Although not extremely popular, plants with more than five-petaled flowers are cultivated. The plants are poisonous and have been implicated in livestock poisoning and illness.



16. *Ranunculus recurvatus* Poir. ex Lam.

Common Names: Hooked Buttercup, Rough Buttercup

Type Description: Poiret in Lamarck, Encyc. Met., vol. 6, p. 125, 1804

Synonyms: *Ranunculus hirsutus* Muhl., *R. saniculaeformis* Muhl., *R. recurvatus* var. *adpressipilus* Weath., *R. recurvatus* var. *laevicaulis* Hager ex Weath., *R. recurvatus* forma *hageri* Weath. ex Peattie

Origin: Temperate, Eastern North America

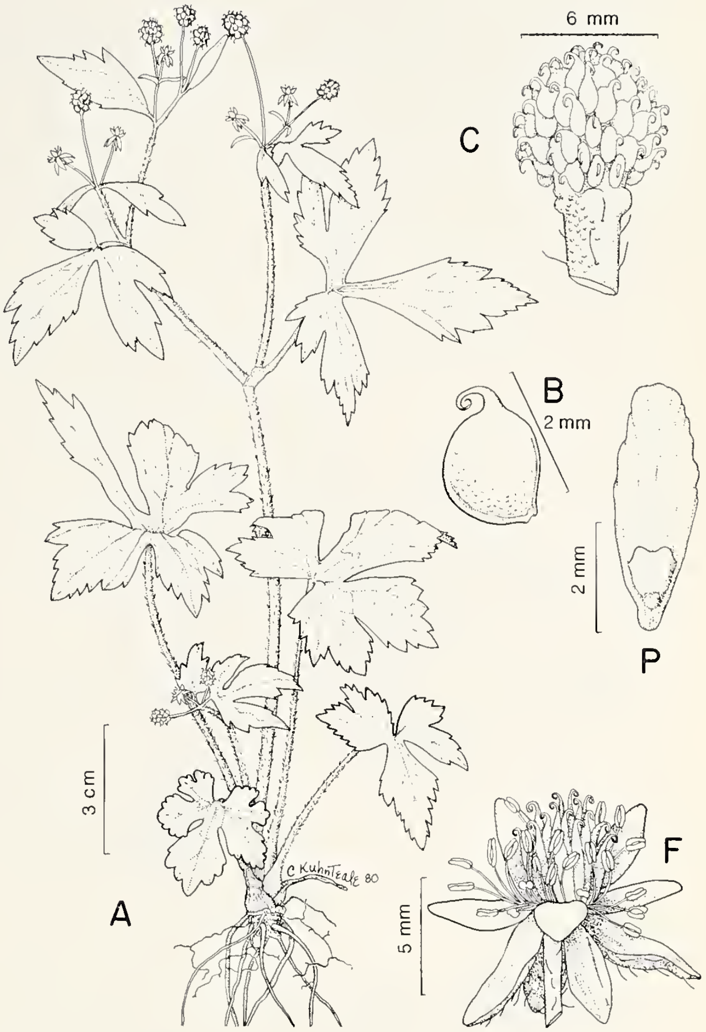
Habitats: Wet to dry woods, streamsides, slopes, ravines

Habit: Erect to ascending, non-stoloniferous terrestrial or palustrine perennials

Flowering: (April) May–June

Fruiting: May–June (early July)

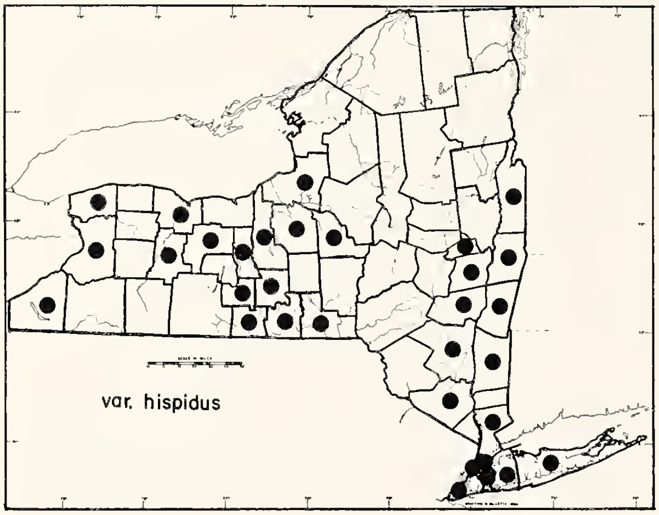
General Distribution: Newfoundland to Florida, west to North Dakota and Texas

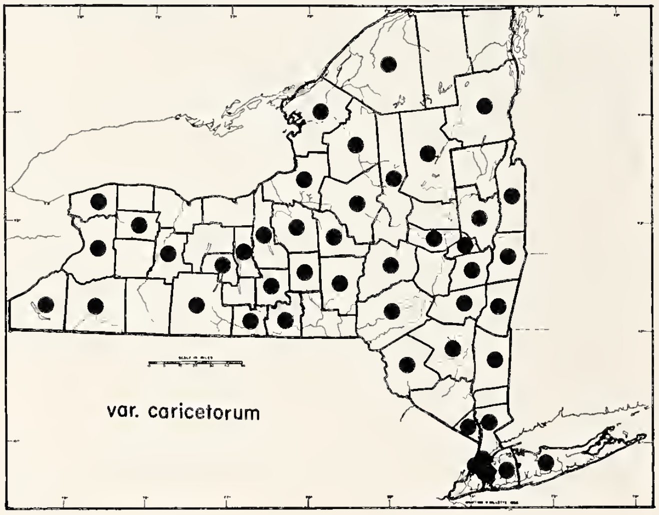


Description: Plants with **bisexual** flowers; **stigma** 1 per ovary, minute, apical ± craterform; **style** 1 per ovary, strongly recurved-uncinate, persistent in fruit, minutely papillate on lower adaxial side; **ovaries** 10–40, clustered on a clavate **receptacle** whose upper portion is granular, pustulose and hispid, becoming a globose **head of achenes,** 5–7 mm long, 4–6 mm wide; **achenes** suborbicular to weakly obovate, flattened, 1.5–2 mm long, ca 1.5 mm wide, somewhat margined, surfaces minutely pitted; **persistent style (beak)** prominent, 1–1.5 mm long, strongly adaxially recurved or ± coiled; **stamens** 10–25, about 4 mm long; **anthers** elliptic or linear; **filaments** slender or transitional to petals; **petals** usually 5, 2.0–6 mm long, 2–3 mm wide, narrowly elliptic to obovate, yellow, cuneate at bases (sometimes clawed in petals transitional to stamens) each with a prominent obdeltoid **nectary scale** at base; nectary scale adnate at sides, forming a pocket with a short, rounded, free portion or with 2 small, free, terminal flap-like lobes (nectary scales of transitional petals narrower with longer free portions); **sepals** 5, greenish, reflexed from near point of insertion, broadly lanceolate, 4–8 mm long, 2–3 mm wide, generally longer than the petals, apices acute, lower surfaces pubescent; **flowers** borne singly on elongating peduncles in a few-flowered corymbose **inflorescence**; **peduncles** pubescent, weakly sulcate, 1–8 mm long in flower, up to 5 cm long in fruit; **subtending leaves** smaller than other cauline leaves, lanceolate or 3-lobed, **cauline leaves** usually 5–9 cm long, 6–12 cm wide, depressed ovate-cordate to shallowingly trianglular in outline, shallowly to deeply 3-lobed, lateral lobes often 2-parted, lobe margins crenate or dentate, surfaces glabrous to pubescent; **basal leaves** usually smaller than median cauline leaves, but similar in shape and dissection; **petioles** 1–17 cm long, glabrous or pubescent; **stem** usually solitary, occasionally branched above, the lowest internode characteristically the longest; **internodes** fistulose, pubescent (to glabrous) erect or ascending, up to 50 cm tall, arising from a small **corm-like base** with fibrous **roots.**

Infraspecific Variation: Varieties and forms have been described, based on the nature of the pubescence. Intermediates are frequent in New York. As with *R. repens* and *R. hispidus* optimum growing conditions may produce unusually large plants.

Importance: *Ranunculas* species are reportedly poisonous.





17. *Ranunculus hispidus* Michx.

Common Names: Hispid Buttercup (var. *hispidus*), Swamp Buttercup, Northern Swamp Buttercup, Marsh Buttercup, "Early Buttercup" (var. *caricetorum*), Swamp Buttercup (var. *nitidus*)

Type Description: Michaux, Fl. Bor. Amer. I., p. 321, 1803

Origin: Eastern North America

Synonyms: *Ranunculus septentrionalis* Poir, *R. marylandicus* Poir. (see also under varieties)

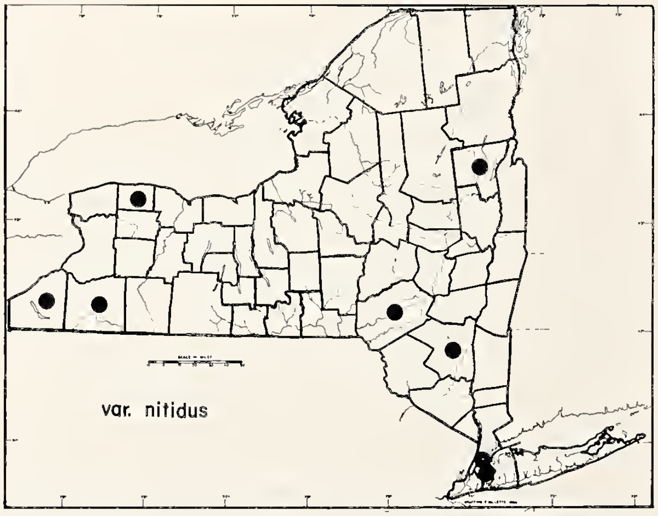
Habitats: Dry to wet woods, clearings, swamps and marshes (see under varieties)

Habit: Erect, repent or stoloniferous, herbaceous perennials

Flowering: April–June

Fruiting: May–June

General Distribution: Eastern United States and adjacent Canada, west to Manitoba, Kansas and Texas



Description: Plants with **bisexual** flowers; **stigma** one per ovary, minute, apical, usually deciduous in fruit; **style** one per ovary conspicuous, 1–3 mm long, somewhat eccentric, usually straight, tapered from a stout base to a slender tip, persistent; **ovaries** 15–40 (–60), clustered on a glabrous to hispidulous, clavate to cylindroid **receptacle** 2–3 mm long in flower, becoming a globose to ovoid **head of achenes** which is 4–12 mm long, 5–10 mm wide; **achenes** weakly biconvex or somewhat flattened, 3–4.5 mm long, 2–2.5 mm wide; obliquely obovate with one shallowly curved and one deeply curved side, narrowly or widely margined, surface glabrous, essentially smooth, but granular under high magnification, dark brown at maturity; **persistent style (beak)** (1–) 2–3 mm long at maturity; **stamens** 25–70, about 4 mm long, spirally disposed; **anthers** elliptic; **filaments** slender; **petals** 5–8 (–10), yellow, glossy, 6–16 mm long, 3–13 mm wide; narrowly to broadly obovate (orbicular), narrowed at bases, deciduous, each petal with a basal **nectary** covered by a scale; **nectary scale** narrowly to broadly obovate with a rounded (to truncate) tip, free and flap-like except at base; **sepals** 5, deciduous, yellowish-green to whitish-green, spreading or reflexed, cucullate, 3–10 mm long, 2–5 mm wide, pubescent on lower surfaces; **inflorescence** irregularly cymose, few-flowered, the flowers born singly on elongating **pedicels**; pedicels pubescent, sulcate, 1.5–6.0 cm long in flower, up to 20 cm long in fruit, each subtended by an **involucral leaf**; involucral leaf varying from lanceolate to ternately compound, the margins entire or dentate; **cauline leaves** alternate, similar to **basal leaves**; basal leaves ternately lobed or compound, ovate-cordate to deltoid in outline, 2–15 cm long, 3–15 (–20) cm wide, when compound the **leaflets** petiolulate, the terminal **petiolule** longer than the lateral ones (up to 3 cm long); **terminal leaflet** 3-lobed, laterals 2-lobed, margins strongly dentate, with **hydathodes**, leaflet bases narrowly to widely cuneate or subcordate; **petioles** 2–30 cm long, sparsely to densely pubescent with expanded and somewhat clasping **stipular bases** (1–9 cm long) with tapered, truncate or round-auricled apices; **stems** erect or ascending to sprawling-repent or **stoloniferous** 15–90 cm long, densely pubescent to nearly glabrous, arising from a short vertical **caudex** and **rootstock** part of which disintergrates (premorse) each year; **roots** fleshy, cord-like or fibrous. (2n = 32, 64 in var. *caricetorum*)

Infraspecific Variation: The taxonomic history of the *Ranunculus hispidus* complex has been a long and confused one. Each variety of *R. hispidus* (as treated here) has been recognized at the species level. Early confusion by American botanists concerning the distictness of native materials from *R. repens* has confounded the problem. We have treated some of these problems under the varieties.

KEY TO VARIETIES

1. Plants repent or stoloniferous .... (3)
1. Plants erect (not repent or stoloniferous) .... (2)
    2. Sepals spreading, not reflexed, margins of achenes narrow (dry habitats) ....
    .... 17a. *R. hispidus* var. *hispidus* (p.)
    2. Sepals reflexed, margins of achenes broad (habitat wet or seasonally moist) ....
    .... 17c. *R. hispidus* var. *nitidus* (p.)
3. Achenes with narrow margins; sepals spreading, not reflexed .... 17b. *R. hispidus* var. *caricetorum* (p.)
3. Achenes with broad margins; sepals reflexed .... 17c. *R. hispidus* var. *nitidus* (p.)

17a. *R. hispidus* var. *hispidus*

Synonyms: *Ranunculus marylandicus* Poir., *R. cardiopetalus* Greene, *R. octopetalus* Greene, *R. belvisii* DC., *R. trifoliatus* Muhl. ex Schlect., *R. hispidus* var. *typicus* Benson, *R. hispidus* var. *greenmanii* Benson, *R. hispidus* var. *marylandicus* (Poir.) Benson, *R. repens* var. *marylandicus* (Poir.) T. &. G., *R. septentrionalis* var. *marylandicus* (Poir.) Chapm.

Habitats: Open, dry woodlands, hillsides and banks

Habit: Erect, terrestrial perennials

Variation: The large synonymy reflects variation in pubescence and number of petals as well as misunderstanding of a foliar leaf-development sequence (see Duncan, 1980). Occasionally plants are found with reflexed sepals. (2n = 32)

17b. *R. hispidus* var. *caricetorum* (Greene) Duncan

Synonyms: *Ranunculus septentrionalis* Poir. (of recent authors and manuals) *R. intermedius* Eat., *R. caricetorum* Greene, *R. sicaeformis* Mack. & Bush, *R. septentrionalis* var. *caricetorum* (Greene) Fern.

Habitats: Wet woods, marshes, swales and shores of lakes and streams

Habit: Repent or stoloniferous, palustrine perennials

Variation: Plants vary greatly in pubescence, leaf color and robustness, but recognition of further taxonomic subdivisions seems unwise. (2n = 64)

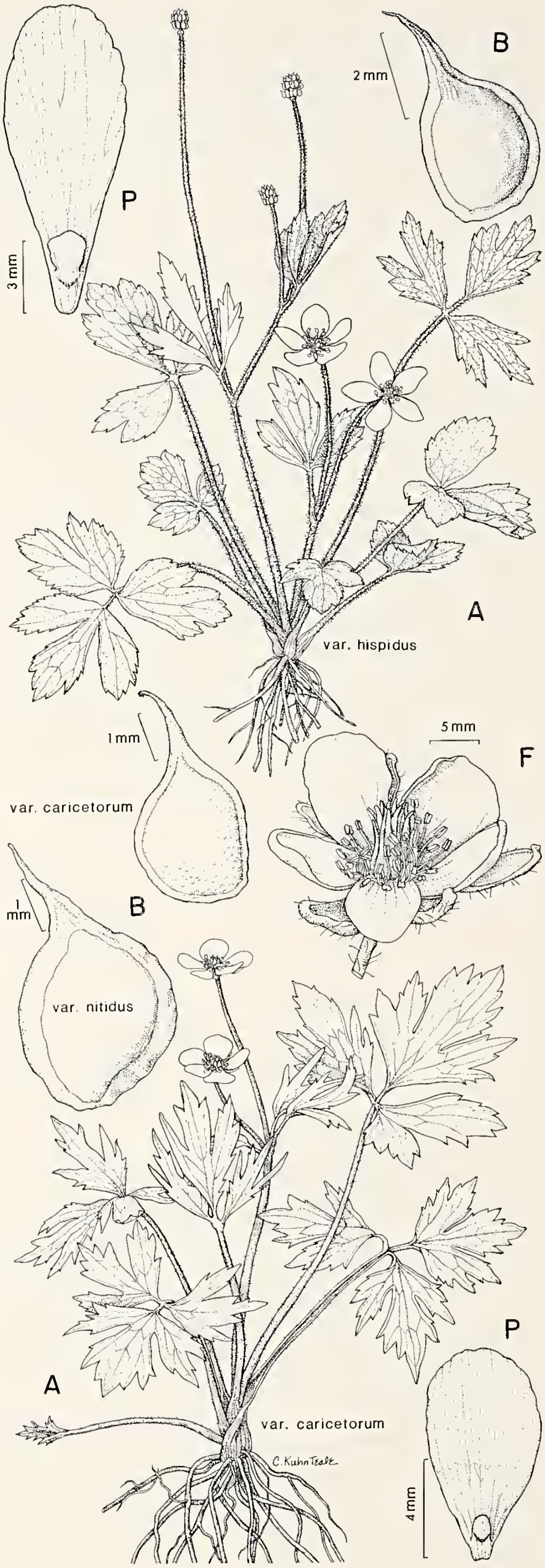
17c. *R. hispidus* var. *nitidus* (Muhl. ex Ell.) Duncan

Synonyms: *Ranunculus septentrionalis* Poir., *R. carolinianus* DC., *R. hirtipes* Greene, *R. nitidus* Muhl., ex Ell. *R. palmatus* Ell., *R. repens* var. *nitidus* (Muhl.) Chapm., *R. septentrionalis* var. *pterocarpus* Benson, *R. hispidus* var. *nitidus* (Ell.) Duncan

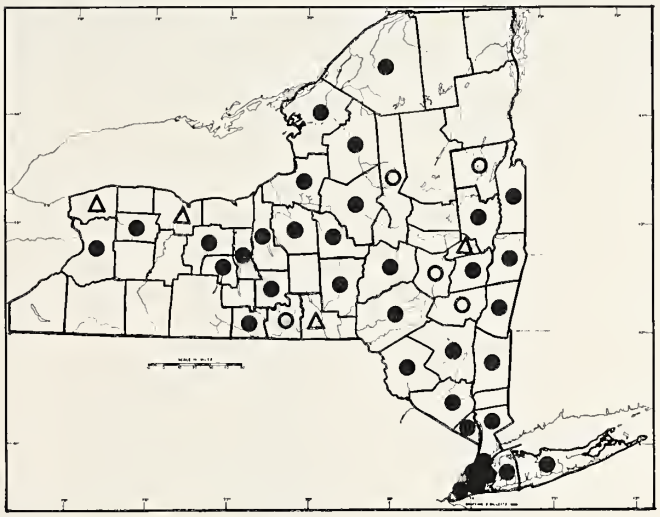
Habitats: Wet woods, Riverbottoms, swamps and ditches

Habit: Sprawling or stoloniferous, palustrine perennials

Nomenclature and Variation: The varietal names, their subsequent uses by authors and the actual variation displayed by this plant group are interlocked in confusion. Muhlenberg (1818), who authored the name, *nitidus*, expressed doubt as to whether it was a variety of *R. repens* ("*an varieras repentis*?"). Elliott (1821), who took up Muhlenberg's name, described the plant as having reflexed sepals and differing from *R. repens* by its lack of runners. Variety *nitidus* may have stolons or they may be absent as in Elliott's southern popula-



tions. Elliott also briefly discussed glabrous forms of *R. repens* as well as concurring that the leaves of "*R. nitidus*" are shiny, as the name indicates. Chapman (1860) reduced *R. nitidus* to varietal status under *R. repens* (1860), then under *R. septentrionalis* (1892). Benson (1948) observed the correlation between prominent achene margins and stoloniferous southern populations (unlike Elliott's), and eventually assigned these plants full species rank (*R. carolinianus*). Duncan (1980) recognized var. *nitidus* under *R. hispidus*, and emended the concept of the distribution of the plants. The combination of reflexed sepals, wide achene margins and stolonifereous habit can be found in populations ranging from the deep south to New York and Minnesota. Especially in those populations from South Carolina and Georgia stolons may be absent.
(2n = 32)



18. *Ranunculus bulbosus* L.

Common Names: Bulbous Buttercup, Bulbous Crowfoot, Meadow-bloom, Gill Cup, St. Anthony's Turnip

Type Description: Linnaeus, Species Pl.', p. 554, 1753

Synonym: *Ranunculus tuberosus* Hornem.

Origin: Europe

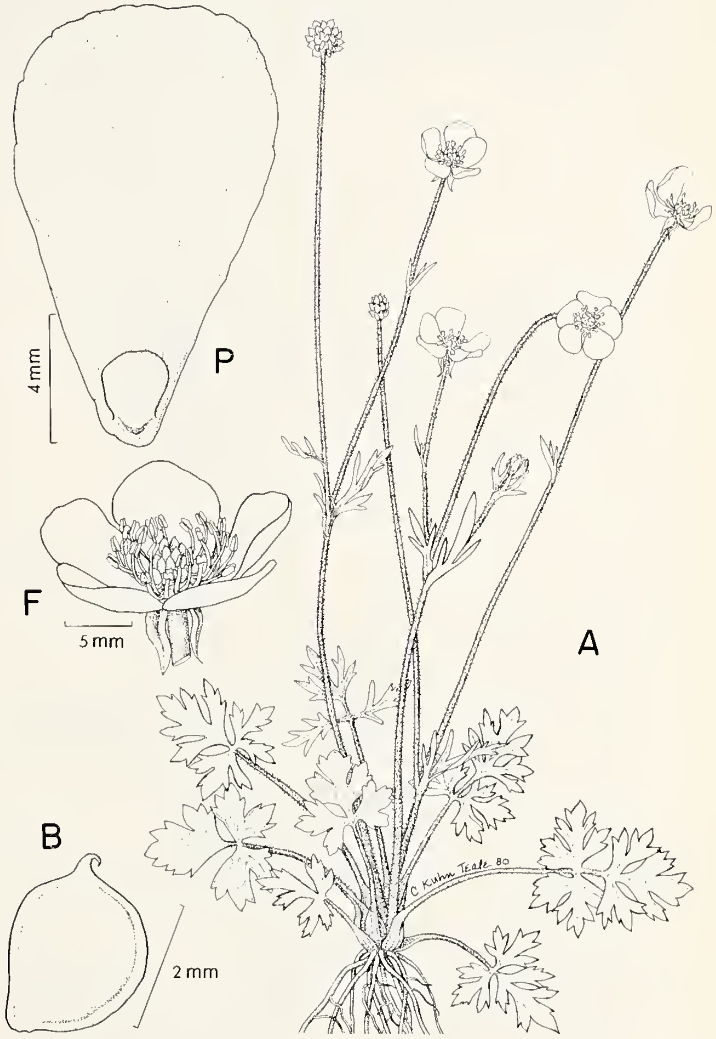
Habitats: Sunny, often rocky places, limestone ledges, waste places, roadsides, gardens, lawns, ditches, fields and streambeds

Habit: Erect perennials with corms

Flowering: April–June

Fruiting: April–July

General Distribution: A weedy escape throughout most of boreal North America (native and also weedy in Europe)

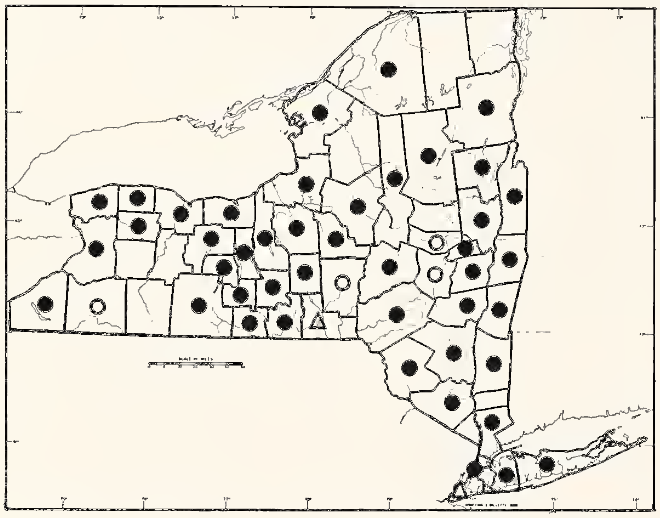


Description: Plants usually with **bisexual** flowers; **stigma** 1 per ovary, persistent in fruit, linear to diffuse, covering the upper adaxial surface of the **style**; style 1 per **ovary,** eccentric, short, somewhat recurved; **ovaries** 15–40, ca 1 mm long, clustered on a conical, pubescent **receptacle,** becoming a globose **head of achenes** 5–10 mm long, 5–10 mm wide; **achenes** 2.5–3.5 mm long, 2–3 mm wide; obovate, strongly margined and keeled, each with a prominent, eccentric, curved **beak (persistent style)** which is 0.4–0.7 mm long; **stamens** 40–80, 4–5 mm long; **anthers** elliptic; **filaments** slender; **petals** 5 (−10), yellow, 7–14 mm long, 7–10 mm wide, broadly obovate, each with a basal **nectary scale**; nectary scale ca 1 mm long, broadly obovate, attached laterally only in the lower ¼ of its length; **sepals** 5 (−12) **greenish,** 6–8 **mm** long, 3–5 mm wide, lance-acute with few long, sericeous hairs, sepals promptly reflexed (90° or more); flowers **born** in an irregular cyme, the **inflorescence** few-flowered with elongating

pedicels; pedicels 9–15 cm long in fruit with furrows near the tip, silky-haired, subtended by 3 to several **involucral leaves** with deeply cut, linear segments; **cauline leaves** few, smaller than most basal leaves and similar, but with more linear segments; **basal leaves** deltoid in outline, 2–7 cm long, 1–5 cm wide, ternately compound or biternately lobed, the terminal leaflet stalked, leaflets varying from obovate to linear, lightly sericeous above to densely silky below; **petioles** villous, up to 20 cm long; **stem** erect, somewhat branched, 15–50 (70) cm tall; **nodes** and **internodes** sparsely to densely pubescent; plants arising from a perennial **corm** 2–14 mm in diameter; **roots** all adventiteous, slender, fibrous or fleshy. (2n = 16)

Infraspecific Variation: Six subspecies are recognized in Europe where the species is native. Two varieties have been historically reported for New York State. These are var. *valdepubens* (Jord.) Briq., a conspicuously hairy type with flattened corms and leaves with short, broad segments, and var. *dissectus* Babey, with narrowly linear to oblong leaf segments. These do not correlate with the European subspecies concept and probably do not deserve recognition.

Importance: This species may be poisonous to livetock if eaten in quantity.



19. *Ranunculus pensylvanicus* L.f.

Common Names: Bristly Buttercup, Bristly Crowfoot

Type Description: Linnaeus f. Suppl., p. 272, 1781

Synonym: *Ranunculus canadensis* Jacq.

Origin: Northern North America

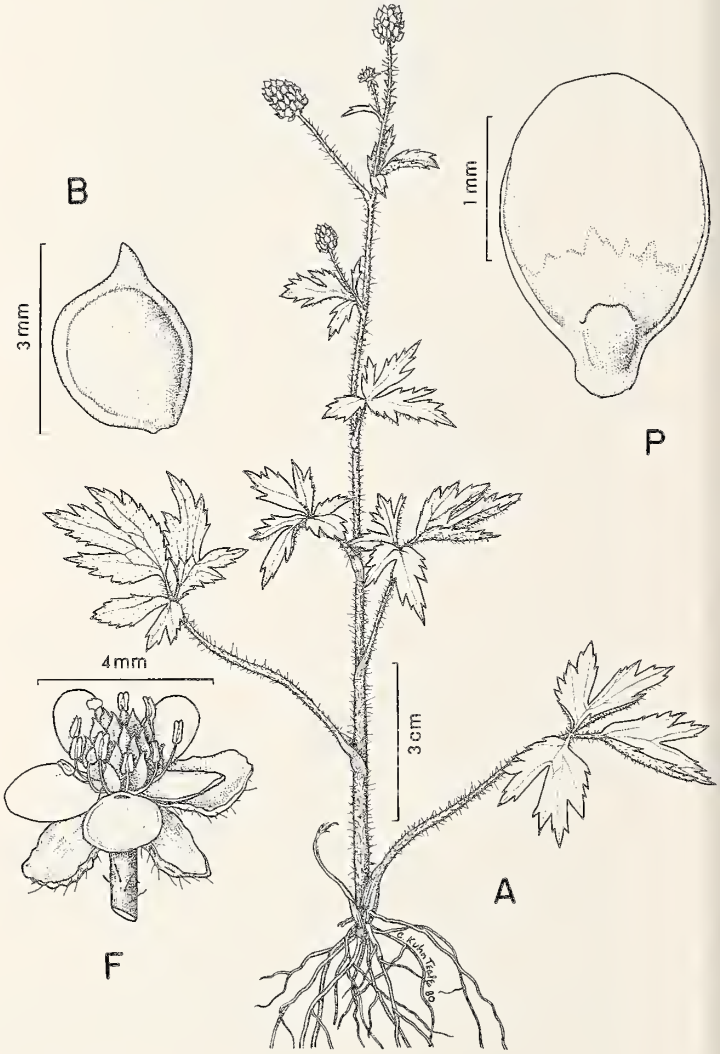
Habitats: Wet soil of marshes, meadows, swamps and shores

Habit: Erect, herbaceous annuals

Flowering: (June) July–October

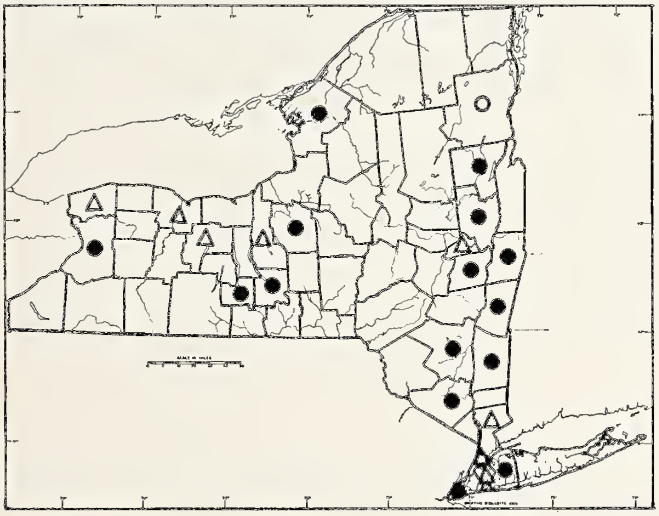
Fruiting: July–October

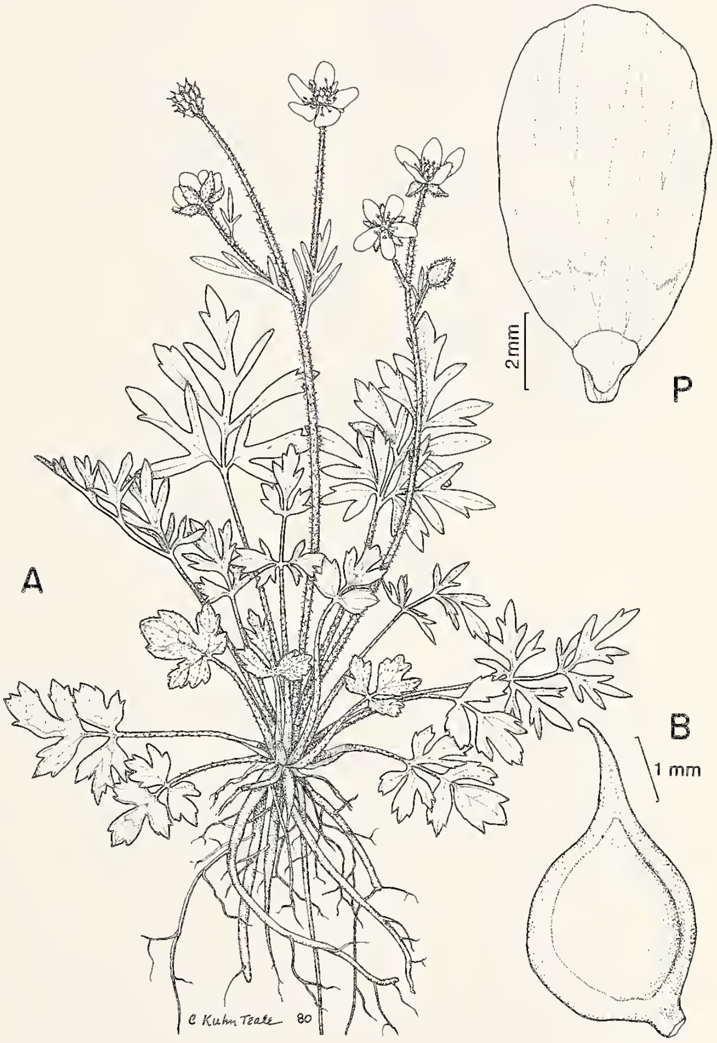
General Distribution: Newfoundland to New Jersey, west to Alaska and Arizona (China, Burma)



Description: Plants with **bisexual** flowers; **stigma** 1 per ovary, minute, apical; **style** 1 per ovary, subulate, up to 1 mm long, apical, but slightly adaxially eccentric, persistent; **ovaries** 60–100, clustered on an elongating, lanceolate to narrowly elliptic, sparsely hispid **receptacle** ca 2 mm long in flower, becoming a cylindric to ovoid **head of achenes** 9–15 (20) mm long, 7–10 mm wide; **achenes** flattened, obovate, 2–3 mm long and wide, narrowly margined, ± keeled, surface minutely pitted (under magnification); **persistent style (beak)** stout, greenish, straight or slightly recurved, 0.5–1 mm long; **stamens** (15) 20–30, spiraling, 2.5–4.5 long; **anthers** elliptic; **filaments** slender; **petals** 5, oval, clawed at bases, 2–5 mm long, 2–4 mm wide, usually shorter than sepals, each petal with a basal **nectary**; **nectary scale** pocket-like or laterally free (upper third), obdeltoid or obovate, ca 0.5 mm long, apex variable, rounded to truncate or slightly retuse; **sepals** 5, ovate to elliptic cucullate, 2.5–5.5 mm long, yellowish-green to whitish reflexed, sparsely hispid on lower surfaces, deciduous; **inflorescence** irregularly cymose-corymbose, **flowers** borne singly on pedicels which elongate mostly in bud; **pedicels** 1–2 cm long in flower, 1.5–3 (5.5) cm long in fruit, pubescent; **subtending leaves** similar to cauline leaves, but smaller and less dissected; **cauline leaves** largest toward the middle of the plant, 3–10 cm long, 5–14 cm wide, ternately compound; **leaflets** hirsute to hispid, petiolulate, margins strongly toothed, tips often with hydathodes, bases rounded to cuneate, terminal leaflet often ternately lobed the lateral ones usually 2-lobed; **petiolules** longest on the terminal leaflets; **cauline petioles** (up to 7 cm) hirsute to hispid, with 1–2.5 cm long **sheathing bases**; **basal leaves** similar in shape to cauline leaves, smaller, often withering early, their **petioles** up to 19 cm long; **stems** erect or ascending, branched, up to 1 m tall, 2 cm in diameter, usually strongly hispid with hairs to 2 mm long; **roots** stout, fibrous.

Importance: Like other species of the genus it is reported to be poisonous.





20. *Ranunculus fascicularis* Muhl. ex Bigel.

Common Names: Early Buttercup, "Prairie Buttercup"

Type Description: Muhlenberg in Bigelow, Fl. Bost. ed. 1, p. 137, 1814

Synonyms: *Ranunculus apricus* Greene, *R. illinoensis* Greene, *R. fascicularis* var. *apricus* (Greene) Fern., *R. fascicularis* var. *deforestii* Davis, *R. fascicularis* var. *typicus* Bens.

Origin: Central United States

Habitats: Rock outcrops, prairies, hillsides, pastures, calcareous flatrock

Habit: Low-growing perennials

Flowering: April–May

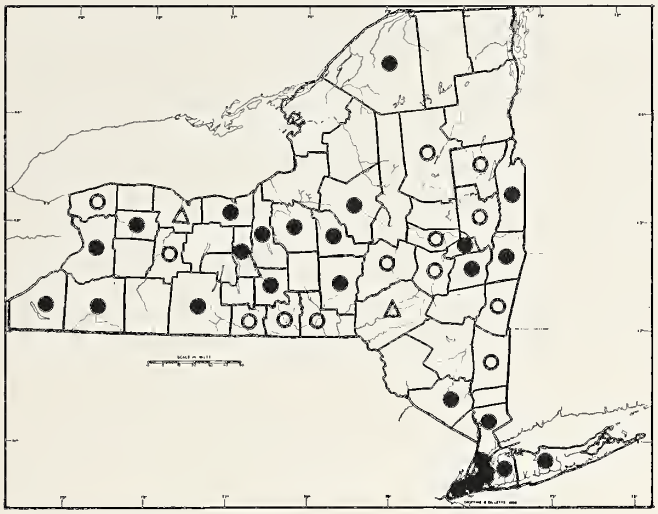
Fruiting: May–June

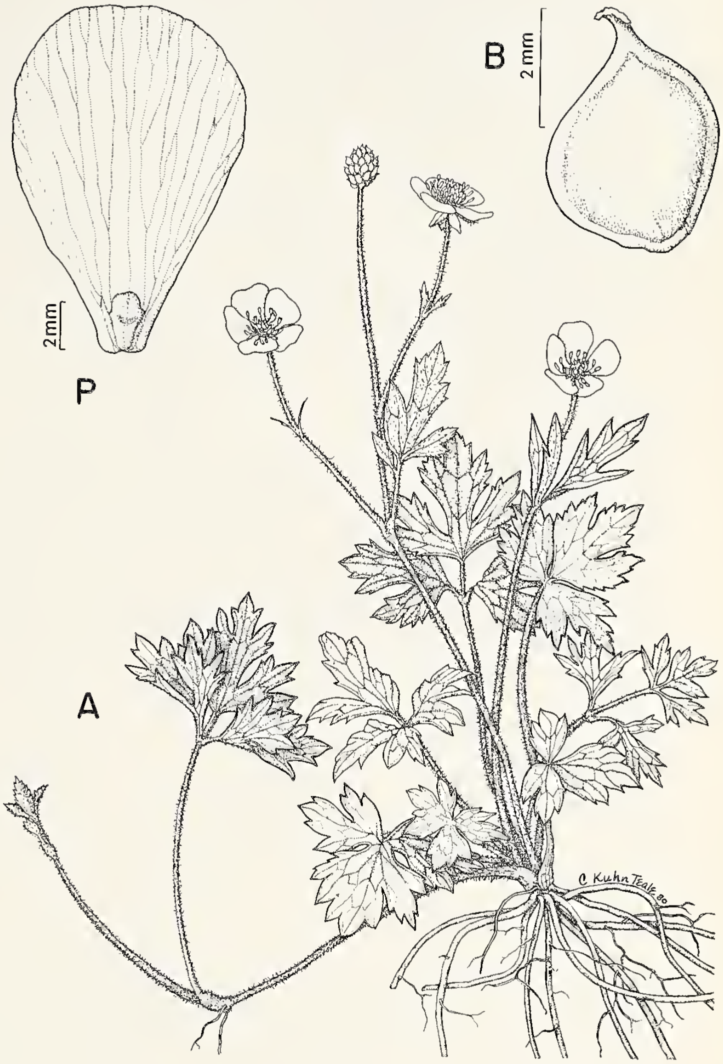
General Distribution: Eastern U.S. and southeastern Canada, Massachusetts to Minnesota, south to Georgia and Texas

Description: Plants with **bisexual** flowers; **stigma** 1 per ovary, minute, apical; **style** 1 per ovary, 1–3 mm long, tapered, ± adaxially falcate, confluent at base where the style is as wide as the apex of the ovary, persistent in fruit; **ovaries** 10–40 clustered on an elongating fusiform to conic, sparsely hispid and pustulose **receptacle,** ca 2 mm long in flower, becoming a turbinate or ovoid **head of achenes,** 4–9 mm long, 4–10 mm wide; **achenes** orbicular to weakly obovate, biconvex, 1.5–3.5 mm long, 1.5–3.0 mm wide, weakly margined or with a prominent abaxial margin; **persistent style (beak)** tapered from a broad base, straight or falcate, up to 3.3 mm long (rarely withered); achenes with short, flat **basal stalks**; **stamens** (30) 35–50 (64), spiraling, 2–4 mm long; **anthers** elliptic; **filaments** slender; **petals** 5–8 (10), yellow, elliptic to obovate, glabrous to sparsely pubescent, 6–10 (15) mm long, 4–8 mm wide, each with a basal **nectary** covered by a scale; **nectary scale** ca 1.5 mm long, obcordate or fan-shaped, laterally free and flap-like; **sepals** 5, cucullate, greenish-yellow to whitish, 6–10 mm long, 3–5 mm wide, patulous or somewhat drooping, lanceolate to ovate, densely pubescent, deciduous; **inflorescence** commonly scapose but often obscurely cymose and few-flowered, **flowers** borne singly on elongating **pedicels**; pedicels 1–5 mm long in flower, up to 9 cm long in fruit, villous, often densely so; **subtending leaves** reduced, simple and linear-oblong or pinnately dissected, sessile or short-petioled; **cauline leaves** similar or less dissected than the larger **basal leaves**; basal leaves in a rosette, ternate to bipinnate, or more commonly pinnate-pinnatifid with 3–5 divisions, blades 2–7 cm long, 2–4 cm wide, oblong or lanceolate in outline, silky pubescent; **petioles** 2–10 cm long, often with a silvery tomentum of appressed hairs; **stipular leaf bases** up to 4 cm long, apically truncate to tapering, often glabrous; **stems** 1–several, erect, not rooting at **nodes,** fistulose, slender, up to 25 cm tall, arising from a short, vertical, annually renewed **caudex**; **roots** dimorphic, slender and fibrous or tuberous (fusiform or clavate) up to 5 mm wide, 4 mm long. (2n = 32)

Infraspecific Variation: No varieties are recognized by Duncan (1980). Most variation in the species occurs outside our range.

Importance: Like other species of the genus, it is reported poisonous.





21. *Ranunculus repens* L.

Common Names: Creeping Buttercup, Clinton's Buttercup, Spotted-leaf Buttercup, Meg-many-feet, Hod-the-rake, Toad-tether

Type Description: Linnaeus, Species Pl., p. 554, 1753

Synonyms: *Ranunculus clintonii* Beck, *R. prostratus* Poir., *R. tomentosus* Poir., *R. pubescens* Lag., *R. lagascanus* DC., *R. reptabundus* Jordan, *R. repens* var. *pleniflorus* Fern., *R. repens* var. *glabratus* DC., *R. repens* var. *villosus* LaMotte, *R. repens* var. *erectus* DC., *R. repens* var. *linearilobus* DC., *R. repens* var. *prostratus* Gaud.

Origin: Eurasia

Habitats: Wet woods, alluvia, ditches, moist pastures, roadsides, fields, lawns, shores; weedy almost anywhere the water table is high

Habit: Prostrate to erect, stoloniferous perennials

Flowering: May–July (through to October in wet years)

Fruiting: June–July (occasionally through October)

General Distribution: An almost cosmopolitan weed.

Description: Plants with **bisexual** flowers; **stigma** 1 per ovary, linear to diffuse and covering the upper adaxial surfaces of the **style**; style 1 per ovary, eccentric, deltoid, recurved, ca 1 mm long; **ovaries** 20–25 (50), clustered on a subglobose to ovoid **receptacle** which is usually pubescent and ca 1 mm long in flower, becoming a globose **head of achenes** 5–7 mm wide, 4–6 mm long; **achenes** obliquely obovate, flattened to weakly biconvex, 2.5–3.0 mm long, 2.0–2.2 mm wide, margined, surfaces glabrous, essentially smooth, but finely granular under magnification, dark brown when ripe; **persistent style (beak)** ca 1 (–2) mm long, with persistent stigma at apex; **stamens** 50–80, spiraled, 4–5 mm long; **anthers** elliptic; **filaments** slender; **petals** (4) 5 (–13) or very numerous in "double" flowers, bright, glossy yellow, 6–12 mm long, 5–10 mm wide, ovate to obovate, narrowed at bases, deciduous, each with a small basal **nectary** covered by a scale; **nectary scale** obovate with a rounded or obcordate tip, laterally adnate at base but free in the upper ¾ of its length; **sepals** 5 (–13), greenish-yellow, deciduous, not reflexed, cucullate, 5–7 mm long, with long hairs on undersurfaces; **flowers borne singly** on elongating pedicels, generally 2 per stem (cymose in some horticultural forms); **pedicels** pubescent, sulcate, 2–10 cm long in flower, 4–15 cm long in fruit; **subtending** leaves lanceolate or linear to linear-lobed ternate; **cauline leaves** reduced upward with shorter petioles, lower ones much like **basal leaves**; basal leaves ternately (biternately) compound, 1.5–6 (11) cm long, 2–8 (13) cm wide, triangular to triangular-ovate or pentagonal in outline, principle divisions sessile to stalked, the terminal **petiolule** up to 4 cm long, the laterals up to 2 cm, leaflets 3 (–5), usually ternately lobed and toothed or scalloped with **hydathodes** at the tips, cuneate to cordate at bases; **petioles** 4–25 cm long, densely pubescent to nearly glabrous, with expanded somewhat clasping, 0.5–2.0 cm long bases which are tapered, truncated or auricled at the junction with the petiole stalk; **flowering stems** erect or nearly so, densely pubescent to glabrous, producing sprawling **stolons** which leaf out and root at the **nodes**; **stems** and stolons arising from a premorse vertical **rhizome** with filiform **roots.** (2n = 32, also counts of 12, 16, 18, 20, 24, 28)

Infraspecific Variation: Numerous varieties have been described on pubescence, leaf shape and other variable characters (see synonymy). One striking variety is worthy of recognition: var. *degeneratus* Schur (var. *plenifolius* Fern.) has numerous petals, robust habit, thicker leaves with scalloped or crenate margins and the terminal leaflets are cordate.

Importance: The variety *degeneratus* is commonly found in cultivation. Like other Buttercups the species is reportedly poisonous.

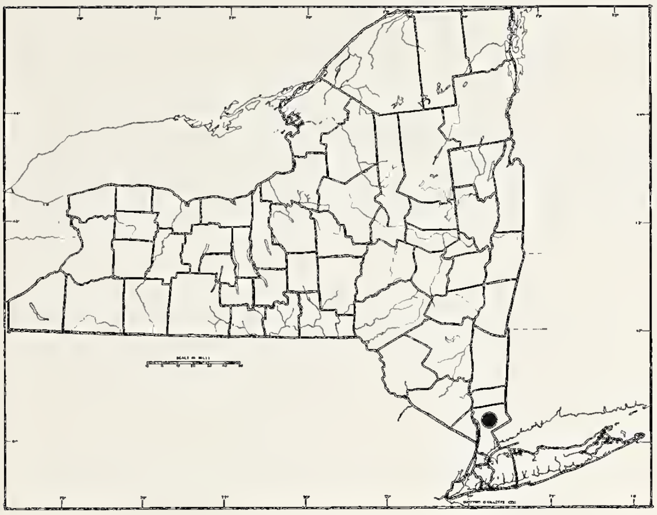
Waifs: *Ranunculus sardous* L. (Oneida, Madison Co. & N.Y. City); *Ranunculus cordiger* Viv. (On ballast, N.Y. City) as *R. philonotis; Ranunculus muricatus* L. (Garden escape, Buffalo)

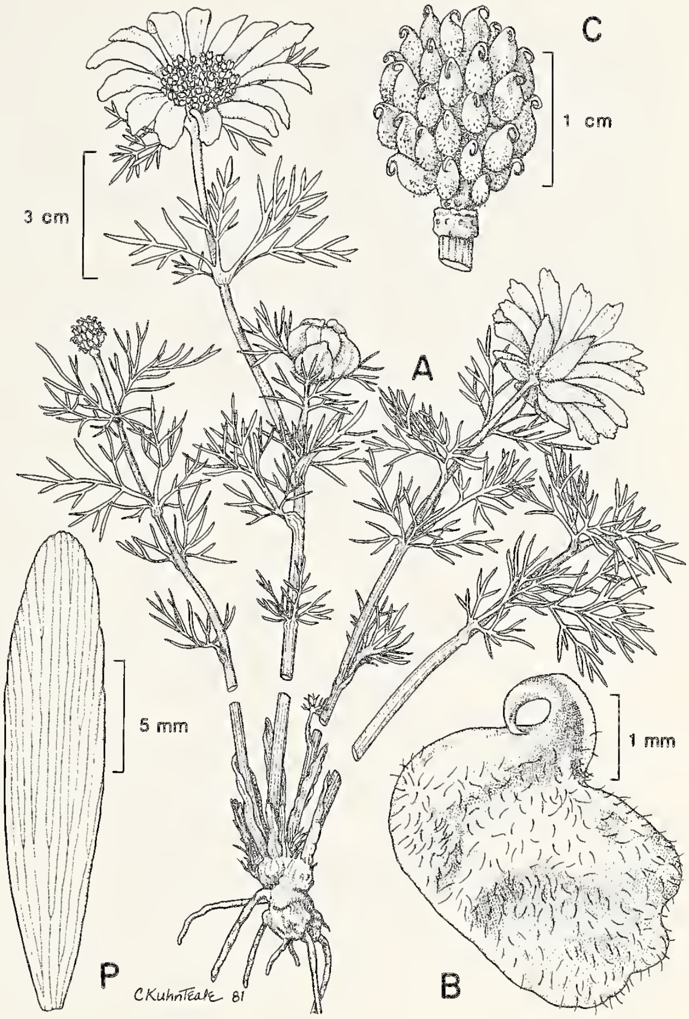
Mistaken Report: *Ranunculus pygmaeus* Wahl. in Gleason (1952) and Gleason and Cronquist (1963).

Note: *Ranunculus gmelinii* DC. is known from very near the borders of New York State with Canada and should be sought within the state. Other species which approach our range are: *R. rhomboideus* Goldie, *R. hederaceus* L. and *R. lapponicus* L.

13. ADONIS

Common Name: Pheasant's-eye
Authority: Linnaeus, Species Pl., p. 547, 1753
A genus of about 30 species of perennial and annual herbs in Eurasia. They resemble *Ranunculus,* but are without nectariferous scales or pits. About six species are commonly cultivated. Of these, *A. vernalis* escapes and persists in New York State, while *A. annua* has been reported as a waif.





1. *Adonis vernalis* L.

Common Names: Pheasant's-eye, Ox-eye, Spring Adonis

Type Description: Linnaeus, Species Pl., p. 547, 1753

Origin: Eastern Europe

Habitats: Escaping gardens, persisting on roadsides and in ditches

Habit: Erect or ascending, perennial herbs

Flowering: April–May

Fruiting: May–July

General Distribution: Escaping cultivation across boreal North America; native to eastern Europe

Description: Plants with **bisexual** flowers: **stigma** 1 per ovary, minute; **style** 1 per ovary, at first not well defined, 1–2 mm long and recurved and appressed to the achene in fruit; **ovaries** fusiform, quite numerous, in a capitate cluster, greenish becoming brown, villous toward their bases, developing into sub-globose **achenes**; achenes rugose, brown, ca 3.5 mm in diameter, villous below, borne in a globose to short-cylindric **head** 1–1.5 cm tall; **seed** 1 per fruit, suspended, ca 2.5 mm in diameter; **stamens** crowded, 70 to over 100; **filaments** 3–5 mm long, slender, somewhat flattened; **anther sacs** 2–2.5 mm long, less than 1 mm wide, golden; **staminodes** and **nectary scales absent**; **perianth** of two distinct series; **petals** 10–20, narrowly to broadly elliptic, ovate or obovate with acute, rounded or truncated (often erose) tips, bright yellow (white), 1.5–3.2 cm long, 0.4–1.6 mm wide; **sepals** 5 (−8) yellowish-green, obovate to ovate-lanceolate, 1–2 cm long, 3–9 mm wide. densely villous toward the base on the abaxial surface; **flowers** 4–8 cm wide, borne singly at the tips of branches; **peduncles** stout, caniculate, 1–4 cm long; **upper cauline leaves** sessile, 1–2-pinnatisect into linear, entire lobes, glabrous except very near the node where they may be villous; **lower leaves** petioled, otherwise much like the upper ones; **petioles** 0–1.5 cm long, sheath-like and transitional to **scales**; scales 1–3 cm long, lanceolate, somewhat sheathing the stem near the base; **nodes** villous; **internodes** ribbed; **stems** branched, clumped, ascending or erect from a tough **rhizome** with leathery **roots.** ($2n = 16$)

Infraspecific Variation: The cultivar "Alba" has white flowers.

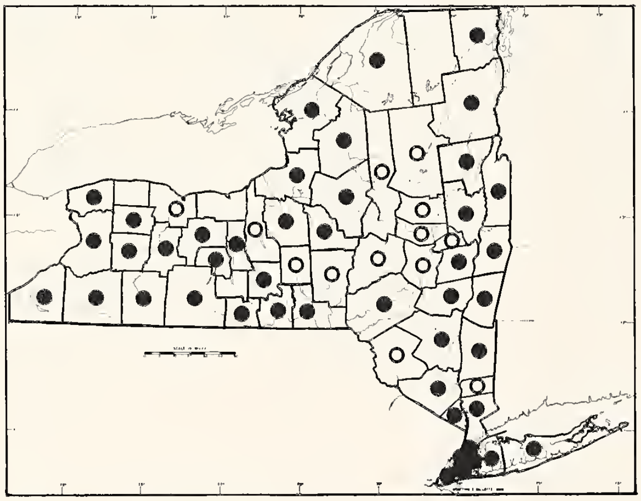
Importance: Extracts of *Adonis* have been used medicinally; the rhizomes and roots contain cardioactive glycosides (Adonidin), sometimes used instead of Digitalis where there is also kidney disease. Adonidin is actually a name used for a combinaton of glycosides. The plants also contain Cymarin and K-Strophanthin. Foliage and roots are reported to poison humans and livestock (at about 1% of body weight), causing gastric irritation, nervous symptoms and even death. *Adonis* is grown as a border or rock-garden plant.

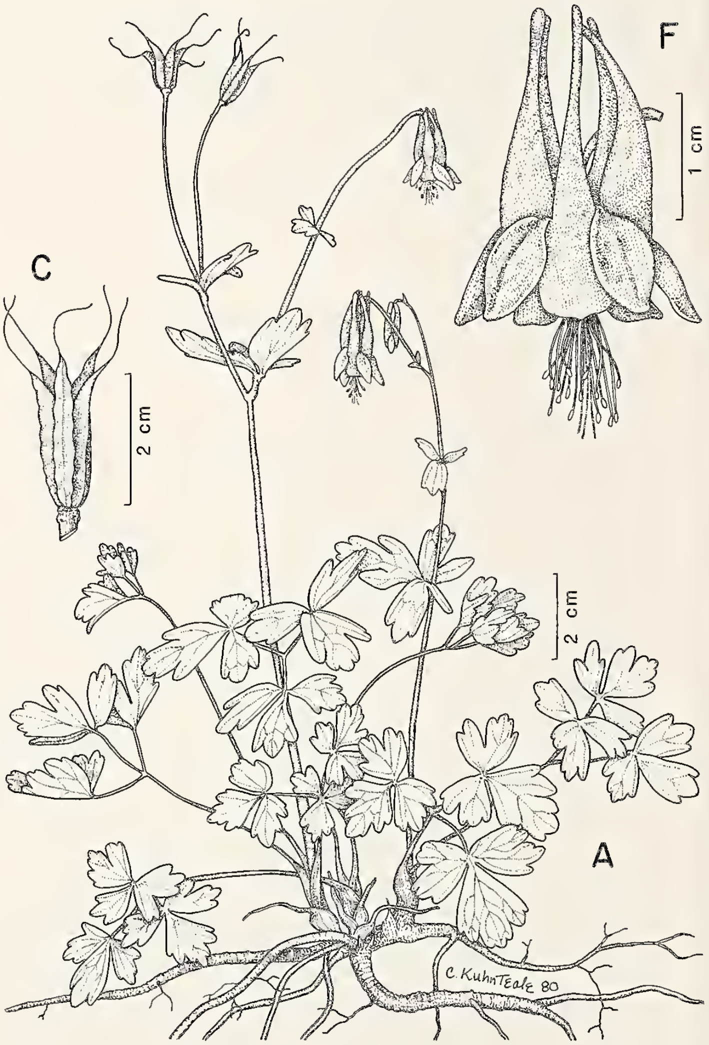
14. AQUILEGIA

Common Name: Columbine

Authority: Linnaeus, Species Pl., p. 533, 1753
This genus has between 40 and 70 species worldwide, depending upon interpretation of the complex patterns of variation and hybridization found within its bounds. The major concentration of species is found in Eurasia, with a few North American representatives, mostly in the west. In the northeastern United States, native plants are of the *Aquilegia canadensis* complex, usually treated as a single species. *Aquilegia canadensis* is often cultivated, as is *A. vulgaris,* a European species which escapes and persists.

Description: Plants with **bisexual** flowers; **stigma** 1 per ovary, **style** 1, per ovary, slender, persistent; **ovaries** usually 5, fusiform, erect, becoming several-seeded **follicles**; **staminodes** present, interior to the **stamens**; stamens numerous, adnate near their bases (connivent); **petals** 5, prolonged backward into hollow **spurs** with **nectaries** at their tips, variously colored, red, yellow, blue, purple or white; **sepals** 5, colored much like the petals, alternating with, and protruding between them; **pedicels** usually slender; **bracts** simple or **leaf-like**; **inflorescence** a loose cyme or flowers borne in upper leaf axils, singly or in pairs; **leaves** bi- or triternate, or simple upward on the stem where they are much-reduced; **leaflets** variously lobed, cut or bluntly toothed; **petioles** reduced upward where they may be absent from upper leaves; **stems** simple to much branched, from a **caudex** or short **rhizome** which bears the fibrous **root system.**





1. ***Aquilegia canadensis*** **L.**

Common Names: Wild Columbine, Rock-bells, Meetinghouses, "Honeysuckle"

Type Description: Linnaeus, Species Pl., p. 533, 1753

Synonyms: *Aquilegia coccinea* Small, *A. latiuscula* Rydb., *A. variegata* Moench., *A. elegans* Salisb., *A. australis* Small (in part)

Origin: Eastern North America

Habitats: Rocky forest, shaded cliffs, sandy woods, ravines, moist river bluffs, less commonly meadow and bog margins

Habit: Ascending to erect, perennial herbs

Flowering: April–June

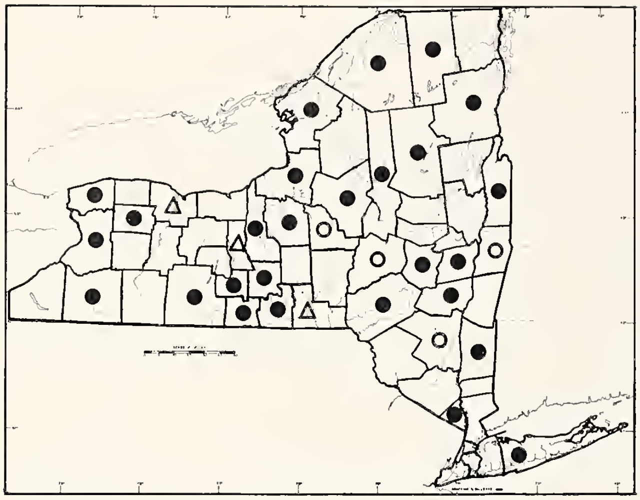
Fruiting: May–August

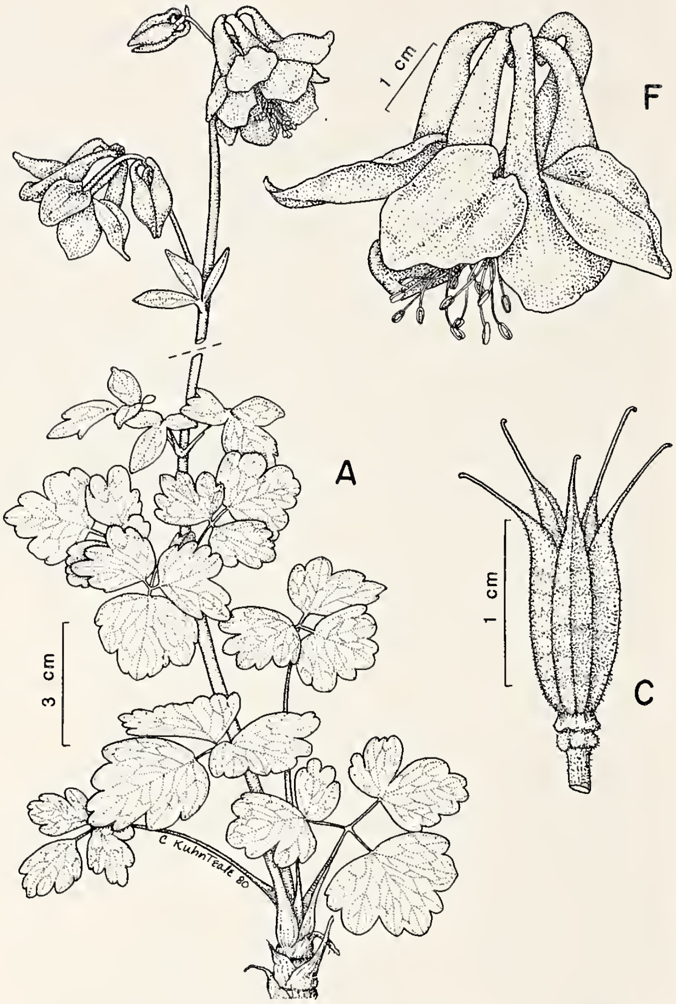
General Distribution: Nova Scotia to Manitoba, Nebraska, south to Arkansas, n. Alabama and n. Georgia (n. Florida)

Description: Plants with **bisexual** flowers; **stigma** 1 per ovary, minute, slightly hooked; **style** 1 per ovary, filiform, 0.9–1.8 cm long, often exceeding the stamens and somewhat twisted, persistent; **ovaries** usually 5, free or cohering slightly at bases, fusiform, 4–6 mm long, ca 1 mm wide; densely villous, with several **ovules**, each ovary becoming a **follicle** in fruit; follicles 5, erect, 1.4–2.6 cm long, 3–7 mm wide, cylindric with tapered tips and persistent styles, dehiscing by adaxial sutures near the apices, prominently veiny, greenish-tan to dark brown, villous, bearing numerous **seeds**; seeds about 1.5 mm long, dark brown, semi-lustrous, curved, slightly angled, with one acute and one blunt tip; **staminodes** 5–10, interior to stamens, 5–7 mm long, pale, fleshy, up to 0.3 mm wide, surrounding the young ovaries; **stamens** about 25–40, 8–15 mm long; **filaments** usually filiform, but some expanded below to resemble staminodia; **anthers** golden, ca 1 mm long; **petals** 5 each with a limb and a backward-directed spur; **petal limbs** trapezoidal, about 4mm long and wide with a blunt **mucro** at the tip, creamy yellow, blending to red where they diverge from the adaxial rims of the **spurs**; spurs usually red, 4–7 mm wide at the mouth, tapering to ca 1 mm, 1.1–2.2 (2.7) cm long, tipped with globose **nectaries** 1.5–2 mm in diameter; **sepals** 5, protruding between the petals, 5–18 (20) mm long, 3–9 mm wide, broadly ovate to ovate-lanceolate with acute to apiculate tips, usually red, sometimes yellowish tinged; **pedicels** 1–15 cm long, glabrous to densely villous-glandular; **bracteoles** 1–6 mm long, lanceolate, villous; **upper leaves** bract-like, simple, lobed or of 2 or more leaflets, often sessile or with slightly sheathing bases; **basal leaves** and lower cauline ones petioled, bi- or triternate; **leaflets** 1–3 cm long and wide, usually lobed and cut, the lobes blunt and variable in size, often glabrous above, but the lower surfaces may be densely villous; **petiolules** glabrous to villous, 0–3 mm long; **petioles** usually villous, weakly ribbed, up to 18 cm long, strongly ribbed and sheathing at bases; **stems** strongly ribbed, glabrous above to densely villous at base, often branched from about the middle, arising from a tough, fibrous **caudex** and branching, lateral **rhizome system,** 0.5–1.2 cm in diameter, with profuse, fibrous **roots.** ($2n = 14$)

Infraspecific Variation: Color forms are known, and these have been recognized as forms and varieties; forma *albiflora* House is known from Onondaga and Bronx Counties and forma *flaviflora* (Tenn.) Britt. is known from Albany and Dutchess Counties. Disjunct populations in northern Florida, once recognized as *A. australis* Small, are more slender and branched, paler in both foliage and flower color, with lanceolate sepals. So-called *A. coccinea* Small has a more robust appearance than typical *A. canadensis;* the flowers are large, with stout spurs and the follicles are at the upper size limits. The plants have much the same range as typical *A. canadensis,* but often bloom a couple of weeks later in adjacent locations. Their habitats are usually moister and more open, such as meadows, swales and bogs. Fernald (1950) recognized four varieties, including the entities discussed above and var. *latiuscula* (Green) Munz, with smaller flowers, often ternately compound leaves and more cut leaflets. This complex deserves careful genetic and biosystematic study. *Aquilegia canadensis,* like other members of the genus, hybridizes freely with other species.

Importance: *Aquilegia canadensis* is grown as a garden ornamental in partially shaded areas or rock gardens. The cultivar "Nana" is only about a foot tall, and makes a good border plant because of its sun tolerance. *Aquilegia* species are poisonous; the seeds have been reported as cause of death in children. Early reports of medicinal uses are vague and unsatisfactory in the light of harmful properties which produce symptoms similar to those of Aconite poisoning.





2. *Aquilegia vulgaris* L.

Common Names: Blue or Purple Columbine, European Columbine, Garden Columbine, European Crowfoot, Garden Crowfoot

Type Description: Linnaeus, Species Pl., p.533, 1753

Origin: Boreal Eurasia

Habitats: Old fields and roadsides, waste places, as a persistent garden escape

Habit: Ascending to erect, perennial herbs

Flowering: May–July

Fruiting: June–September

General Distribution: Escaping from cultivation in cooler climates circumboreally

Description: Plant with **bisexual** flowers; **stigma** 1 per ovary, slightly hooked, each at the tip of a filiform **style**, 7–11 mm long; **ovaries** usually 5, fusiform, densely villous, 4–5 mm long, with numerous **ovules**, each ovary becoming a many-seeded **follicle** in fruit; follicles 5, erect, somewhat fused near the bases 15–28 cm long, 4–6 mm wide, fusiform, dehiscing by terminal-adaxial sutures, tips with **persistent styles,** walls veiny, greenish-tan to brown, villous and glandular; **seeds** oblong-lenticular with a sharp keel along one edge, shiny brownish-black, 3 mm long by 1.5 mm wide; **staminodes** 8–10, interior to the stamens, whitish, opaque to hyaline, lanceolate, with blunt tips, ca 5 mm long, 1 mm wide; **stamens** about 25–30, 6–12 mm long; **filaments** slender or slightly expanded toward bases; **anthers** ca 1.5 mm long, golden; **petals** 5, with a limb and backward directed spur; **petal limbs** broadly triangular with acute to obtuse tips, 0.6–1.2 cm long, 0.5–1.0 mm wide, usually blue-purple (pink); **spurs** 1.0–2.6 cm long, colored like the limbs, broad at the mouth (up to 1.3 cm), each tapering rather abruptly to a constricted area which is often recurved and bears a **nectary** at its tip; **sepals** lance-ovate, 1.6–2.5 cm long, 0.5–1.0 cm broad, petaloid, usually purple or colored like the petals; **pedicels** 1.5–11.0 cm long, villous; **bracteoles** lanceolate, villous, 3–5 m long; **bracts** 3-lobed, much like leaflets, densely villous below; **upper leaves** ternate, nearly sessile; **lower leaves** biternate (to triternate) with elongate axes; **leaflets** (1) 2–5 cm broad, (1) 2–4 cm long, cut and lobed, with rounded tips, mostly glabrous above, villous below; **petioles** villous, (0) 1–40 cm long, reduced up the stem; **stem** branched from above the middle, terete, villous to glandular, arising from a tough **caudex** with many fibrous **roots.** (2n = 14)

Infraspecific Variation and Hybridization: As with most cultivated Columbines, there has been much hybridization and introgression in the recent history of the species. A number of flower colors are known, including pink, white pale blue and salmon.

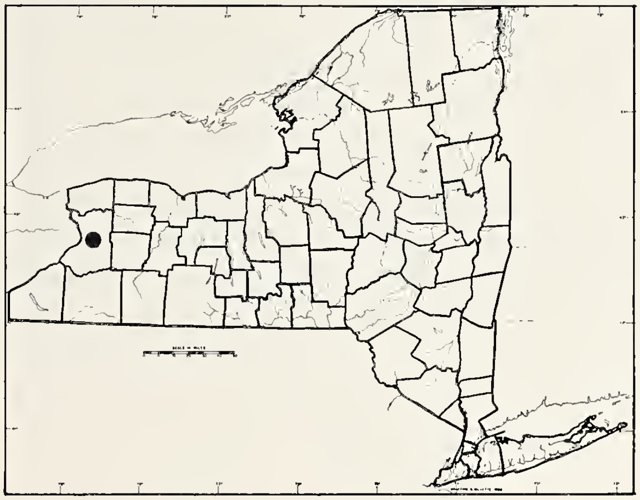
Importance: This species was more popular as a garden flower 50–100 years ago; populations which escaped long ago tend to be more uniform and retain their slightly smaller, purple flowers, whereas more recent collections show more variation. Like other Columbines, this species is poisonous.

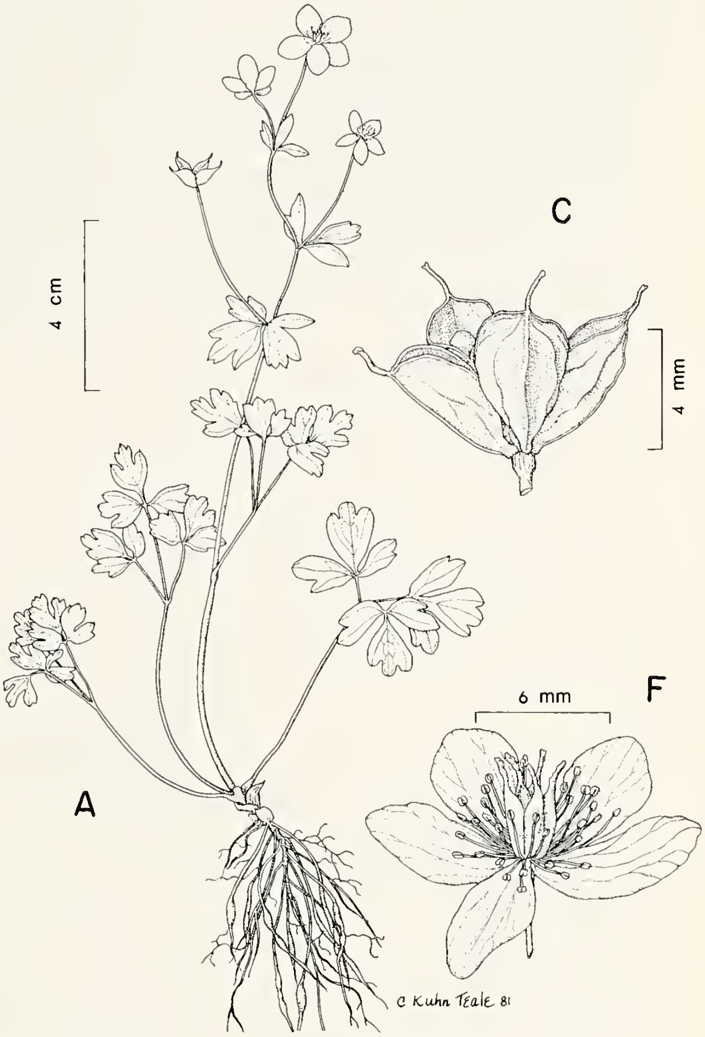
15. ISOPYRUM

Common Name: False Rue Anemone

Authority: Linnaeus, Species Pl., p. 557, 1753

A genus of about 25 species, mostly native to Asia, with a single species in Europe and several in western and central North America. They are sometimes cultivated.





1. *Isopyrum biternatum* (Raf.) T. & G.

Common Name: False Rue Anemone

Type Description: Rafinesque, Journ. Phys., Sci., p. 70, 1820

Synonym: *Enemion biternatum* Raf.

Origin: Central North America

Habitats: Calcareous woodlands and thickets in moist, rich soil

Habit: Erect, perennial herbs

Flowering: April—early June (earlier elsewhere)

Fruiting: May—June

General Distribution: (New York State) southern Ontario to Minnesota, south to west Florida and Arkansas (Texas)

Rarity Status: Possibly extirpated in New York State; known only from a single pre-1840 specimen labelled "Buffalo New York".

Description: Plants with **bisexual** flowers; **stigma** 1 per ovary, minute or slightly enlarged and recurved; **style** 1 per ovary, less than 1 mm long; **ovaries** 4 (3–6), oval, often swollen on one side, ca 1 mm long, on a small **receptacle, ovules** 2–4 (6); **follicles** divergent, 4–7 mm long, 3–4 (5) mm wide, somewhat compressed, greenish to tan, glabrous, with a few prominent veins and transverse veinlets, dehiscing by a suture along the swollen abaxial side; **persistent style (beak)** slender, ca 1 mm long; **seeds** 2–5, smooth; **stamens** mostly 25–30, ca 4 mm long; **anthers** subglobose; **filaments** clavate, slender below; **staminodes absent; perianth** of a single whorl of petaloid lobes; **perianth lobes (sepals)** 5 (-7), ovate, round-tipped (acute), 4–10 (14) mm long, 3–8 (11) mm wide, white; **peduncles** slender, glabrous, 8–25 mm long in flower, up to 4.8 cm long in fruit; **flowers** borne singly, axillary or terminal; **cauline leaves** biternate, much like the basal ones but smaller with shorter petioles; **basal leaves** biternate (triternate), 2–7 cm broad, the **leaflets** 4–18 (24) mm long, 2–14 (17) mm wide, (entire) 2–3 (5-)lobed with shallow to deep sinuses, lobes round to acute-tipped, **leaflets** glabrous, darker green above; **petiolules** slender, up to 8 mm long; **petioles** glabrous, ribbed, up to 15 cm long in basal leaves, reduced upward to about 1 mm in leaves subtending the flowers; **stems** ribbed, glabrous, 10–20 (30) cm tall, from a tuberous **rootstock**; **lateral roots**, tough, fibrous. (2n = 14)

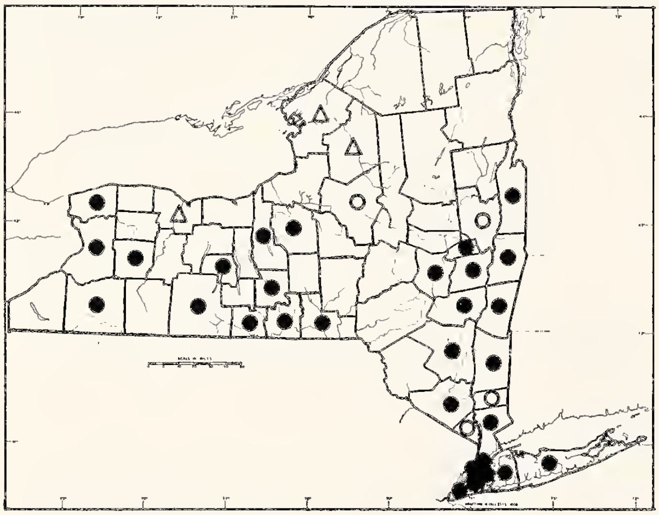
Note: Some recent authors (eg. Keener, 1977) have revived the genus *Enemion*.

16. ANEMONELLA

Common Names: Rue Anemone

Authority: Spach, Hist. Veg. 7: 239, 1839

This genus has a single species, and partly for this reason it has been treated in various and often confusing ways. The two other genera to which the species has most often been ascribed are *Thalictrum* and *Anemone*, but it bears more superficial resemblance to *Isopyrum*. Nonetheless, we feel that it has enough individuality to stand on its own in a family where relationships are ancient and generic limits are shaky at best. This species is grown as an ornamental, and its tubers are sometimes used as food.



1. *Anemonella thalictroides* (L.) Spach

Common Names: Rue Anemone, Woods-potato, "Wild-potato"

Type Description: Linnaeus, Species Pl., p. 542, 1753

Synonyms: *Anemone thalictroides* L., *Thalictrum anemonoides* Michx., *Thalictrum thalictroides* (L.) Eames & Boiv., *Syndesmon thalictroides (L.) Hoffm.*

Origin: North American Arctotertiary

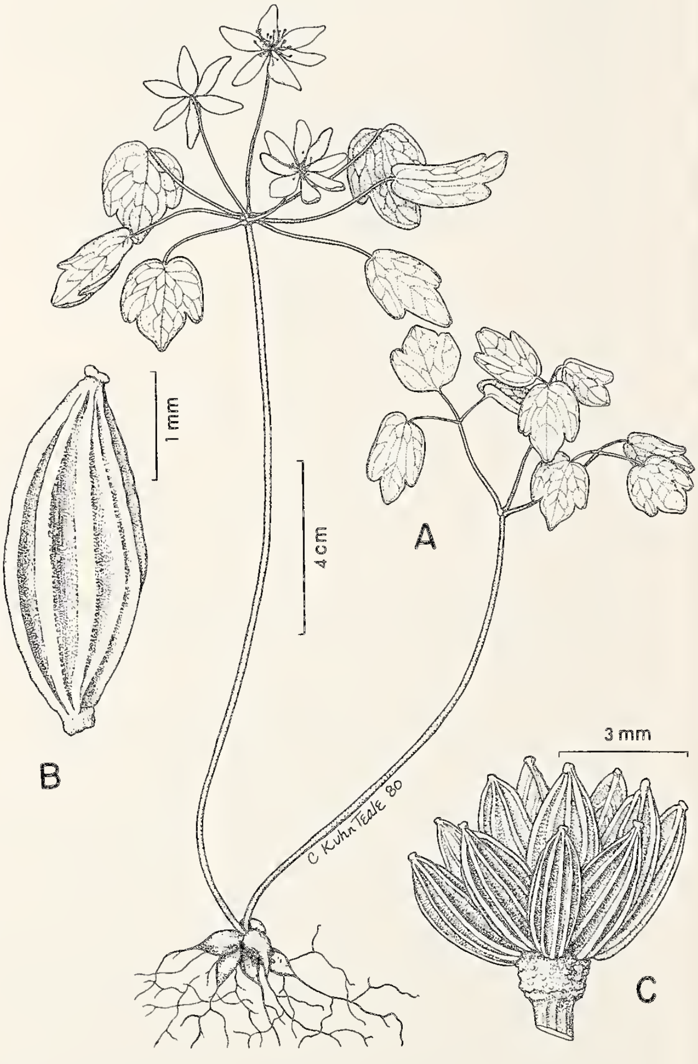
Habitats: Moist to dry woods and partial clearings

Habit: Low-growing, perennial herbs

Flowering: May—June (earlier elsewhere)

Fruiting: June—July

General Distribution: New Hampshire to Minnesota and Kansas, Oklahoma; mostly Appalachian southward to Arkansas (north Florida)



Description: Plants with **bisexual** flowers; **stigma** 1 per ovary, sessile, flat topped, persistent; **style** not evident; **ovaries** (5) 8–12 (15), free, fusiform, ribbed, 1–2 mm long, with a single pendulous **ovule**, each ovary becoming an **achene** in fruit; achenes 3.5–5 mm long, ca 1.5 mm wide, borne in an umbel-like cluster of (4) 6–15, tan to brown, fusiform, strongly 8-ribbed (10), each containing a single **seed** which is fusiform and minutely papillose; **stamens** 15–30; filaments slender, 1–4 mm long; **anthers** globose, golden, ca 0.3 mm long; **staminodes** and **petals** absent (except abortive flowers); **perianth parts (sepals)** separate, 5–10 (11), oval to narrowly oblong or obovate, white or pink-tinged, (2) 4–15 mm long, 2–1 mm wide; **inflorescence** a loose, terminal, umbel-like cluster of flowers, often of different sizes and stages of maturity; **pedicels** 1–3 (4) cm long, slender, glabrous, inconspicuously ribbed; **upper leaves** 2 (3), ternate but sessile, the **leaflets** arising from the plant apex with the flowers on **petiolules** 0.4–4.5 cm long (rarely sessile); **lower leaves** basal, 1 to 3-ternate, up to 25 cm tall; **leaflets** shallowly and bluntly 3-lobed (5), rarely unlobed, oval in outline, 1–2.5 cm broad and long, glabrous, paler beneath, showing intricate venation; **petioles** and other leaf axes slender, angled, petioles up to 20 cm long on the basal leaves, absent from the upper ones; **stipules** papery, hirsute, sheathing at the plant base; **stems** slender, glabrous, 8–35 cm tall, from a short **caudex** at the crown of a cluster of tuberous **roots**; roots fusiform, 1–4 cm long, up to 1.5 cm in diameter, starch-filled, the new ones generated from the caudex in spring. (2n = 42)

Infraspecific Variation: The flowers may be green in forma *chlorantha* Fassett. Teratological forms vary. As in *Ranunculus*, all flower parts may be petaloid (forma *favilliana* Bergs.)

Importance: The plants are a favorite in partially shaded, old-fashioned rock gardens. Tubers are boiled and eaten in Pennsylvania, where the plants are known as "Wild Potato".

17. THALICTRUM

Common Name: Meadow-rue

Authority: Linnaeus, Species Pl., p. 545, 1753

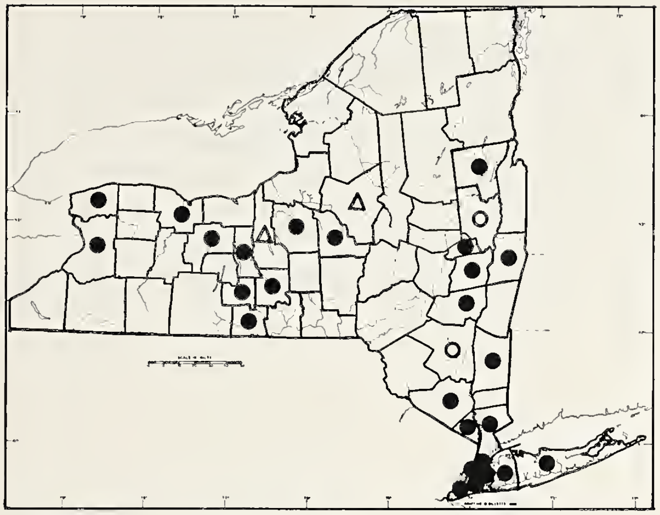
A genus of 50 or more species, primarily of woods and marshes in the North Temperate Zone. The circumboreal arctic-alpine species, *Thalictrum alpinum*, does not reach New York State. Meadow-rues are taxonomically difficult the world over, and our two, native species-pairs are no exceptions. Though the flowers of *Thalictrum* species are small, the stamens are showy, and the foliage, much like that of Columbines, makes them desirable for certain horticultural uses.

Description: Plants **polygamo-dioecious, dioecious** or with only **bisexual** flowers; **stigma** 1 per ovary, the stigmatic surface linear or S-shaped, covering most of one side of the style or enclosing it (together conventionally called stigma); **style** 1 per ovary, persistent or deciduous with the stigma; **ovaries** 4–15 (18), fusiform, becoming elongate, flattened or inflated **achenes** which are usually prominently veined or ribbed, borne **sessile** or on **stipes** in some species, 4–15 in number, in dense to lax, drooping clusters; **stamens** 6-many, showy; **filaments** dilated or filiform; **anthers** oblong to linear; **perianth** of a single series, often 4-parted, petaloid but usually inconspicuous, greenish to red-purple, cream or almost white, often early-deciduous; **pedicels** and **peduncles** slender to fleshy; **inflorescence** a panicle or raceme, sometimes nearly flat-topped; **bracts** of several types from scarious to leaf-like; **leaves** 1–4 ternately compound, larger toward the plant base, often grading into bracts above; **leaflets** orbicular to elongate, glabrous to pubescent and/or glandular, especially beneath, entire or more often 3-many lobed or toothed; **petiolules** variable in number and length; **petioles** variable in length or lacking, more or less dilated at the base, sometimes strongly sheathing at the node; **stipules** and **stipels** (of varying degrees) may be present; **stems** slender to stout, single or more often much-branched and ribbed, arising from a perennial **caudex**, with or without **rhizomes**; **root system** tough, fibrous.

KEY TO SPECIES OF THALICTRUM

1. Most leaflets with 4–5 (or more) lobes, often crenate .... (4)
1. Most leaflets with 2–3 lobes or entire .... (2)
  2. Stigmas (in fruit) mostly over 3 mm long, slender, not papillose, up to ¾ the achene length or more; filaments filiform, not clavate .... *Thalictrum dasycarpum**
  2. Stigmas (in fruit) mostly under 3 mm long, thick and densely papillose, about ½ the achene length; filaments gradually dilated upward, clavate .... (3)
3. Leaflets with dense to sparse, minute **glandular hairs** beneath (rarely glabrous) the margins strongly revolute, leathery textured, with prominent venation below .... 1. *Thalictrum revolutum* (p.)
3. Leaflets with slender, **pilose hairs** beneath (rarely glabrous), not strongly revolute-margined or leathery, the venation below not raised or particularly prominent .... 2. *Thalictrum pubescens* (p.)
  4. Basal caudex ascending, flexuous, from a horizontal rhizome; achenes somewhat bilateral, the few prominent ribs fusing toward a falcate tip; stigmas mostly persistent; blooming in June—July in rocky, open places .... 3. *Thalictrum venulosum* (p.)
  4. Basal caudex erect, stiff; rhizomes, if present, branching laterally from the caudex; achenes fusiform, densely parallel-ribbed; stigmas mostly deciduous; blooming in April—May, usually in woodlands .... 4. *Thalictrum dioicum* (p.)

* **Note:** *Thalictrum dasycarpum* Fisch. & Llal. (Purple Meadow-rue) is known from a single specimen (in fruit) from New York State. The location is on a well-traveled Adirondack trail, leaving suspicion that the plant might have been a waif. Until a well established colony is verified, the species will not be treated as a member of the flora. Reports of *T. dasycarpum* from the Buffalo and Albany areas have so far turned out to be based on incorrect identifications.



1. *Thalictrum revolutum* DC.

Common Names: Waxy Meadow-rue, Purple Meadow-rue, Skunk Meadow-rue

Type Description: DeCandolle, Syst. I., p. 173, 1818

Synonyms: *Thalictrum purpurascens* Pursh var. *ceriferum* Austin, cited in part by House (1924) as *T. dasycarpum* Fish. & Lall.

Origin: Eastern North America

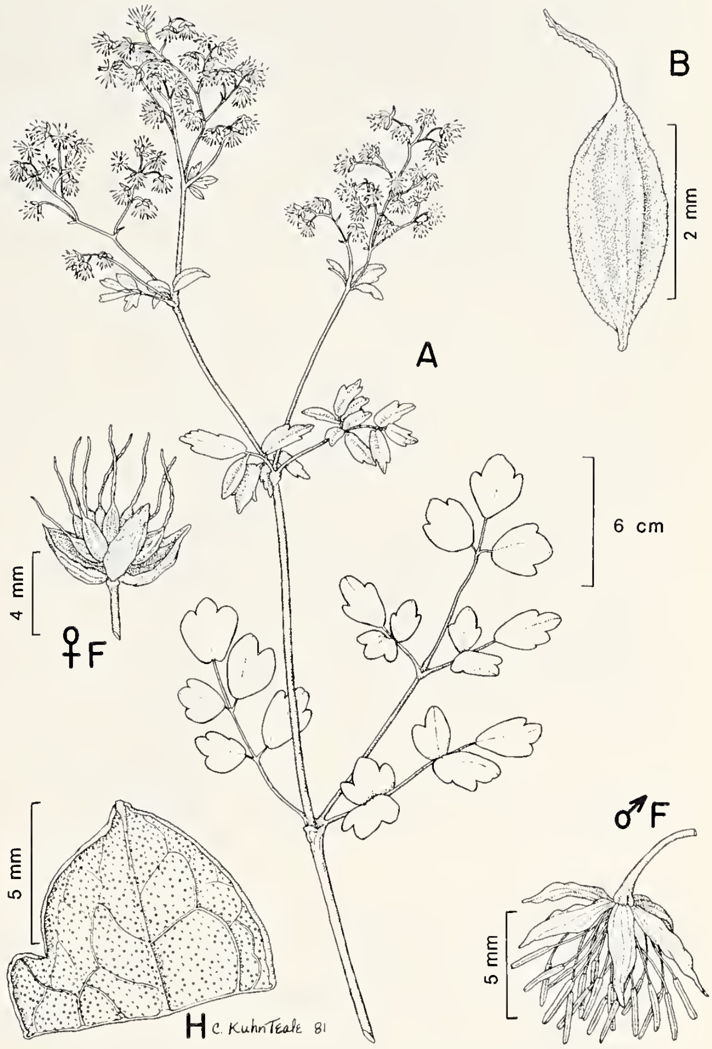
Habitats: Rocky places, open woods, clearings, thickets, prairies, sandplains and barrens (rarely dry meadows)

Habit: Erect, branching perennial herbs

Flowering: May—July (September)

Fruiting: June—October

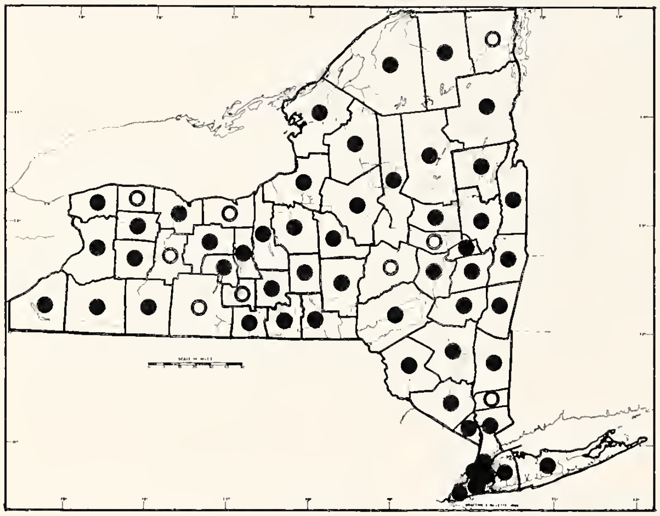
General Distribution: Massachusetts to Ontario, south to Florida and Arkansas



Description: Plants **dioecious** or **polygamo-dioecious;** **stigma** 1 per ovary, linear, densely glandular-papillose, 0.8–1.5 mm long, becoming up to 2.5 mm long, somewhat persistent until fruit is completely mature; **style** short, usually glandular-pubescent, persistent as a short beak; **ovaries** 5–15, fusiform, ribbed, ca 2 mm long, becoming **achenes** 3–5 (6) mm long, 2–3 mm wide, which are brownish, strongly (but sparsely) ribbed and obovate in outline, their surfaces often covered with tiny, glandular hairs; achenes borne in capitate **heads** of 5–12 (15); **seed** 1 per fruit, glossy brown, ca 2.5 mm in diameter; **stamens** numerous (few in bisexual flowers), 2–7 mm long, pale, showy, soon drooping; **filaments** slightly to conspicuously dilated toward their summits, clavate, with ridged to minutely scaly surfaces; **anthers** 1.5–2.8 mm long, golden; **perianth** parts 4–6, free, oval to obovate, petaloid, 1.5–2.3 mm long, 0.8–1.1 mm wide with erose margins, pale greenish-cream to purple-green, early decidouous; **pedicels** and **peduncles** glabrous or very slightly glandular, angled or grooved; **inflorescence** a series of racemes and panicles in the axils of upper leaflets and bracts, most plants either predominantly male or female; **bracts** green, leaf-like, lanceolate to oval or even lobed; **leaves** 2–3 pinnately compound, sessile (with stalked leaflets only) at the base of the inflorescence grading upward into bracts, petioled on lower parts of the stem; **leaflets** coriaceous, entire to 2–3 (5) lobed, narrowly oval, ellipsoid or broadly ovate, 1–4.5 (6) cm long, 0.5–3.5 (4) cm wide, the margins (most) minutely but tightly revolute, upper surfaces glabrous (or sparsely pubescent), lower surfaces most often with a dense covering of short, often **waxy-glandular hairs**, these less commonly sparse (lacking in a rare form) or the surfaces muricate to white-papillose; **petiolules** usually glabrous, not pilose; **petioles** short or virtually lacking except for the sheathing bases on upper cauline leaves, up to 15 cm long and grooved on lower leaves; **stems** branching from the base and above, often stout and up to 1.5 cm in diameter at the base, 0.5–1.4 m tall, from a fibrous, basal **caudex,** 0.5–2.2 cm in diameter, with fibrous **roots.** (2n = ca 134)

Infraspecific Variation: This species is a member of a subtle complex which includes *T. pubescens, T. dasycarpum* and *T. macrostylum.* It remains distinctive so long as the unique waxy hairs are produced, but these are lacking in forma *glabrum* Pennell. The glandular hairs are sometimes replaced by non-glandular hairs which look like the stalks of glands, or the surface may be white-papillose or merely muricate. One could speculate that these are phenotypic responses to the hot, sunny habitats in which the plants grow, but transplant and common-garden studies are needed before this species and its allies are understood.

Importance: This species and *T. dasycarpum* contain Thalicarpine, a substance used in cancer thereapy. Extracts of *T. revolutum* have been shown to contain a number of alkaloids, producing hypotensive effects and showing anti-microbial activity in laboratory animals.



2. *Thalictrum pubescens* Pursh

Common Names: Tall Meadow-rue, Fall Meadow-rue, Muskrat-weed, Late Meadow-rue, King-of-the-meadow

Type Description: Pursh, Flora Amer. Sept., p. 388, 1814

Synonyms: *Thalictrum polygamum* Muhl. *(nomen nudum), T. canadense* L. (misapplied), *T. corynellum* DC., *T. divergens* Link, *T. purpurascens* L. of some authors, *T. canadense* Mill. var. *hebecarpum* (Fern.) House (possible *T. dasycarpum*), *T. zibellinum* Greene and 13 other combinations by Greene (see Boivin, 1944)

Origin: Eastern North America

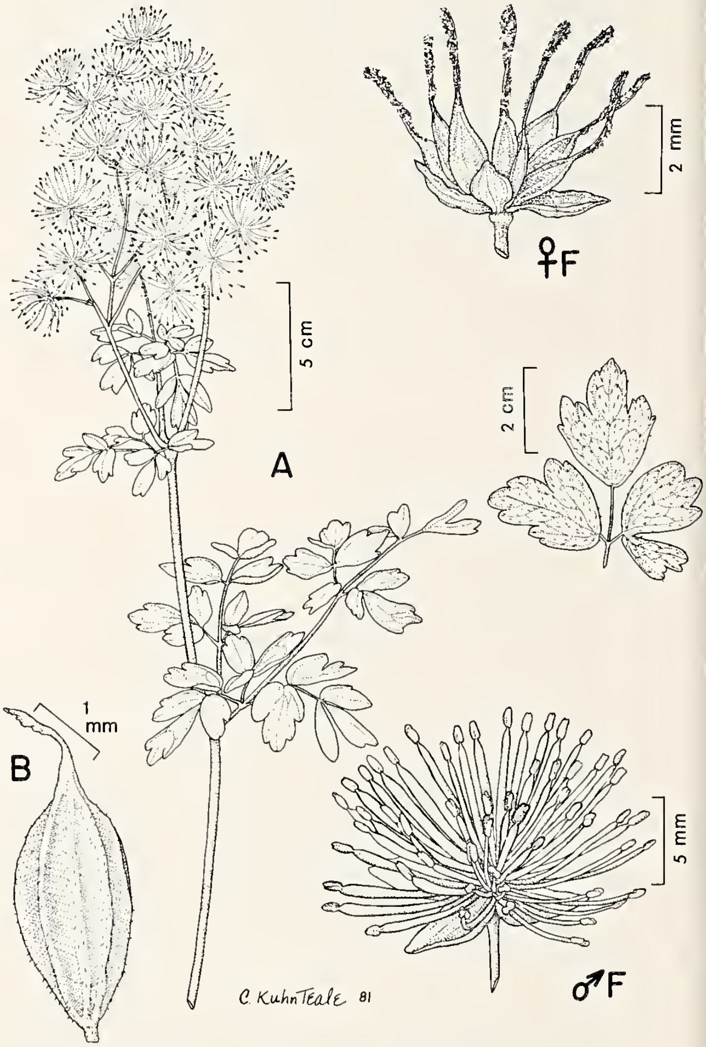
Habitats: Moist places, swamps, bog margins, rich, wet woods and thickets, meadows and streambanks

Habit: Tall, erect to ascending perennial herbs

Flowering: June—August

Fruiting: July—October

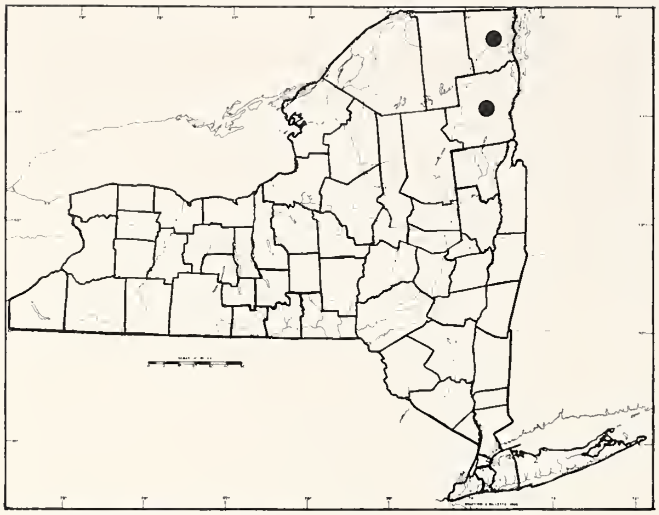
General Distribution: Labrador to Quebec, south, mostly along the Appalachians to North Carolina, west to Indiana



Description: Plants **dioecious** or **polygamo-dioecious**; **stigma** 1 per ovary, 0.5–1.5 mm long becoming up to 2.3 mm in fruit, linear, densely papillose, usually persistent; **style** persistent, short, combined length (with stigma) up to 2.5 mm in fruit; **ovaries** (5) 8–18, fusiform, ribbed, ca 2 mm long, becoming **achenes** 3–5 mm long, 2–3 mm wide, with a few prominent ridges, somewhat falcate-contorted, the surfaces brownish, glabrous or with a fine pubescence; achenes short-stipitate, borne in sub-globose **heads** of 5–18 fruit; **seed** 1 per fruit, shiny brown, ca 2.5 mm in diameter; **stamens** numerous (few in bisexual flowers), 2–6 mm long, pale, showy; **filaments** slenderly to conspicuously dilated toward their summits, clavate, with ridged and minutely scaly surfaces; **anthers** 0.5–1.5 mm long, golden; **perianth parts** 4 (-6), free oval to obovate, entire to slightly erose, with rounded (or apiculate) tips, petaloid, 0.4–3.0 mm long, 0.3–1.8 mm wide, greenish-cream to purplish, early-deciduous; **pedicels** and **peduncles** glabrous or puberulent; **inflorescence** of a series of racemes and panicles in the axils of upper leaflets and bracts, sometimes flat-topped; **bracts** leaf-like, intergrading with leaves below, green, pilose to nearly glabrous; **leaves** 2–3 pinnately compound, sessile and reduced to leaflets on the upper stem, petioled near its base; **leaflets** coriaceous to membranaceous and thin, entire or 2–3 (5) lobed, broadly lanceolate to oval with blunt, rounded or obtuse (apiculate-tipped) lobes, 0.5–7.2 cm long, 0.4–5.9 cm wide, margin usually not revolute, upper surfaces glabrous or sparsely villous, lower surfaces densely to sparsely puberulent or villous to glaucous or slightly papillose (glabrous); **petiolules** densely to sparsely villous (rarely glabrous); **petioles** stout, up to 18 cm long on basal leaves, glabrous to sparsely villous, grooved, sheathing strongly at bases (reduced to sheaths in upper leaves); **stems** branching, stout to slender, up to 2.2 m tall, from a tough, basal **caudex** and fibrous **root system.** ($2n = 84$, 154)

Infraspecific Variation: This species is extremely closely related to *T. revolutum* and often difficult to distinguish from it. Both are variable in leaf pubescence and may produce glabrous individuals. The variety *intermedium* under *T. polygamum* (Fernald, 1950) is a category devised to take care of intermediates between the species (which we feel may be considered a single taxon after experimental study). Variety *hebecarpum* (Fernald, ibid) has many of the characters of *T. dasycarpum.*

Importance: Thalicarpine, a substance used in cancer therapy, has been isolated from this species as well as from *T. revolutum* and *T. dasycarpum.*



3. *Thalictrum venulosum* Trel.

Common Name: Veiny Meadow-rue

Type Description: Trelease, Proc. Bost. Soc. Nat. Hist., vol. 23, p. 302, 1886

Synonyms: *Thalictrum confine* Fern. (in part), *T. campestre* Greene, *T. lunellii* Greene, *T. purpurascens* L. (*sensu* DC.), *T. purpurascens* L. var. *monoicum* DC., *T. dioicum* × *purpurascens* (in Trelease)

Origin: Boreal North America

Habitats: Open, rocky places, shores and forest margins

Habit: Erect, perennial herbs

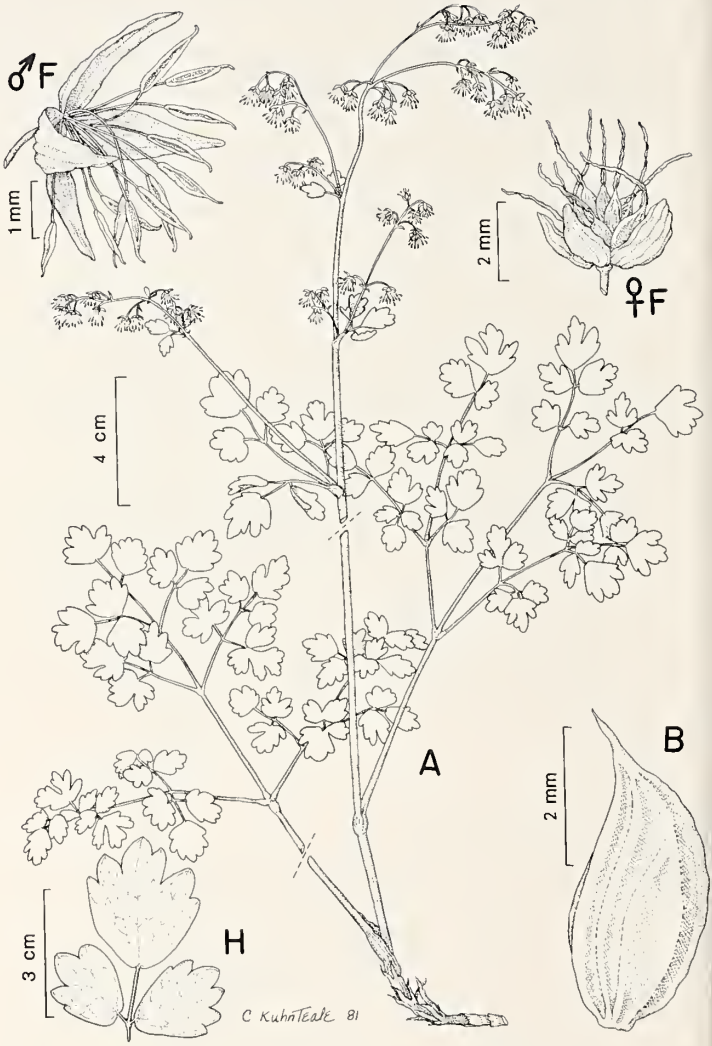
Flowering: June—July

Fruiting: Late June—September

General Distribution: Labrador to British Columbia, south to Oregon, Colorado, Michigan, Minnesota, New York and Vermont

Rarity Status: This species is threatened in New York State (under *T. confine* in pre-1981 publications)

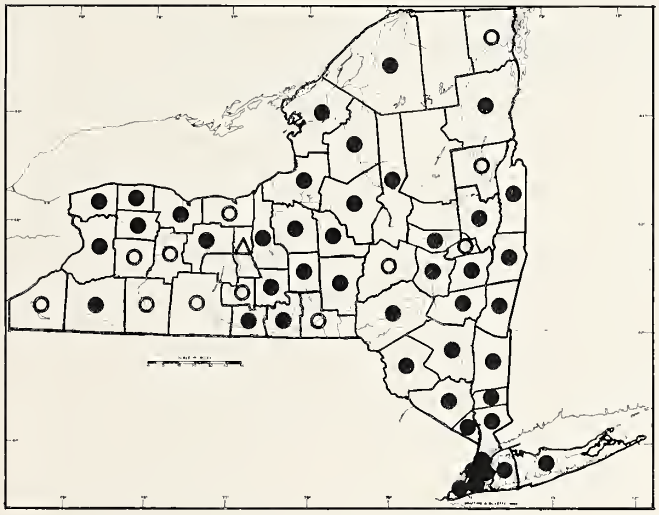
Note: The following description applies only to New York State specimens examined by the senior author. It therefore compares closely with monographic descriptions of *T. venulosum* var. *venulosum.*

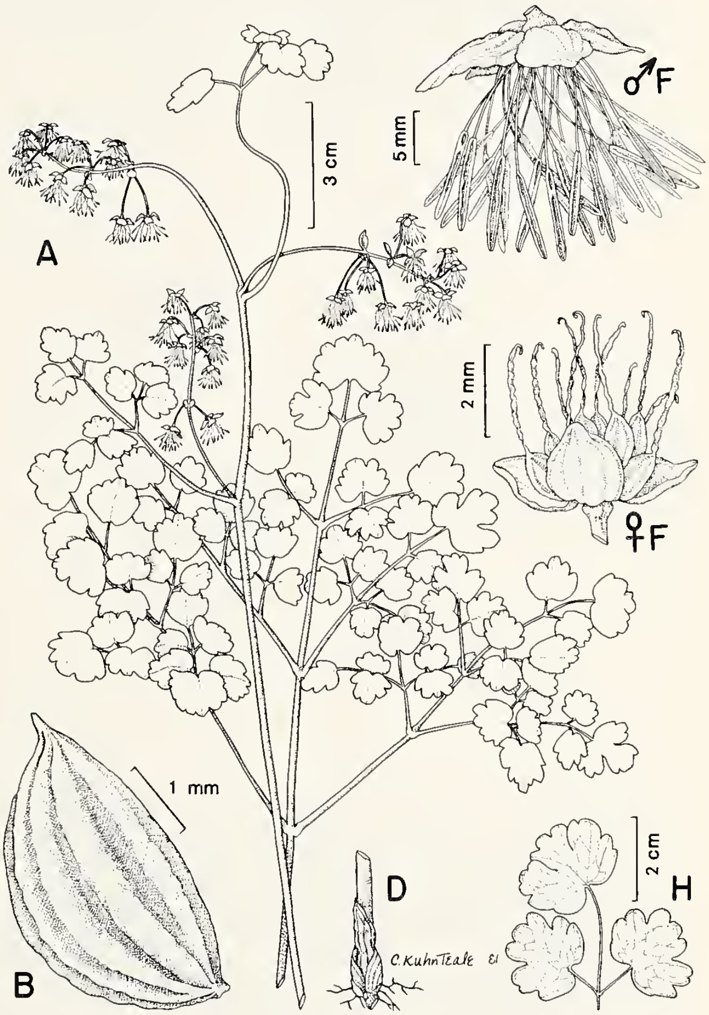


Description: Plants **polygamous** or **dioecious; stigma** 1 per ovary, papillose, purplish, persistent, (1.5) 2–3 mm long in fruit; **style** short, 1 per ovary; **ovaries** 4–12 (13), fusiform, ribbed, ca 3 mm long, 1 mm wide, glabrous, becoming bilaterally symmetrical **achenes;** achenes 1–8 (9), brownish, sessile, (3-) 4.5–6.2 mm long, ovoid, falcate-contorted toward the persistent stigma, ribs prominent, branching and sparse, somewhat irregular in pattern; **seed** 1 per fruit, shiny brown, ca 3.5 mm in diameter; **stamens** (3) 4–6 (9) mm long; **filaments** slender-filiform, 1.0–3.5 (6) mm long; **anthers** golden, linear, 2–3.5 mm long with a **subulate tip** 0.2–0.5 mm long; **perianth** parts 4–6, free, pale green to dark purple-green, ovate to lanceolate with acute tips, 2.5–3.5 (4) mm long, 1.0–1.5 (2) mm wide, somewhat scarious (especially in male flowers); **pedicels** and **peduncles** ribbed, purple-green, glabrous; **inflorescence** a panicle of racemose branches, almost naked, with much-reduced bracts and upper leaflets; **upper bracts** minute, sheathing, at the nodes of the inflorescence; **lower bracts** pale, from 2 mm long, lanceolate and scarious grading to lobed leaflets below; **cauline leaves** 2–3 (4) in number in addition to a **basal leaf; leaves**

biternate, triternate or reduced to leaflets subtending the inflorescence, the petiole represented only by a sheath; **lower leaves** petiolate; **leaflets** oval to reniform with (acute) obtuse to truncate bases, (4) 5–12 lobed and crenately toothed, 0.3–2.5 (2.8) cm in diameter, pale green, often glaucous with raised reticulate veins below; **petiolules** and joints often with patches of villous hairs, otherwise glabrous; **petioles** sheathing (often auriculate) at their bases (0) 0.1–15.5 cm long; **stem** glabrous or slightly villous, ribbed, erect, 4–8 dm tall, from an ascending, slender **caudex** which arises from the tip of a cord-like **rhizome; roots** thin, fibrous.

Infraspecific Variation: Lengths and proportions of flower parts, as well as the average fruit and style lengths, vary considerably within this species. Variety *venulosum* is widespread in northwestern North America and has fertile parts smaller in general than those of the rarer eastern "variety *confine*". New York specimens conform more closely with var. *venulosum.*





4. *Thalictrum dioicum* L.

Common Names: Early Meadow-rue, Quicksilver-weed, Shining-grass, "Feathered Columbine"

Type Description: Linnaeus, Species Pl., p. 545, 1753

Synonyms: *Thalictrum laevigatum* Michx., *T. cornuti* of authors not L., *T. pauciflorum* Raf. (and others), *T. pulchellum* Pursh ex Lec., (also varieties, see Boivin, 1944), *Leucocoma dioica* (L.) Nieuwl.

Origin: Eastern North America

Habitats: Rich woodlands, cliffs and clearings, often in moist, rocky places

Habit: Erect, perennial herbs

Flowering: April–May (NY)

Fruiting: May–July

General Distribution: Labrador to North Dakota, south to Missouri and Georgia

Description: Plants **dioecious**; **stigma** 1 per ovary, 1.0–2.5 (3) mm long, somewhat persistent, but deciduous in mature fruit, papillose, purplish when young; **style** almost completely covered by the stigmatic surface; **ovaries** 5–9 (11), fusiform, ribbed, ca 3 mm long, 1 mm wide, glabrous, becoming terete, symmetrical **achenes**; achenes 1–7 (9), brown, sessile, 3.5–5.5 mm long, 1.5–2.5 mm wide, oblong-ovoid to fusiform, densely and evenly parallel-ribbed (with some rib-branching); **seed** 1 per fruit, shiny, brown, ca 3 mm in diameter; **stamens** numerous, 5–7 (9) mm long, drooping; **filaments** slender-filiform, yellow, 2–5 mm long; **anthers** golden, linear, 1.3–3.8 (4.1) mm long, without prominent subulate tips; **perianth parts** 4 (–6), free; in male flowers: 1.2–2.0 mm long, ovate to elliptic, with obtuse to rounded tips, purple-green; in female flowers: 2.5–4.2 mm long, broadly oval to obovate with rounded tips, pale, creamy-green to purple-tinged; **pedicels** and **peduncles** ribbed, glabrous; **inflorescence** an open panicle, developing with the leaves in spring, usually subtended by a petioled leaf (less frequently by 1–3 leaflets); **bracts** sheathing, scarious and leaflet-like, pale to purple-stained; **leaves** 2–4 ternately and pinnately compound, all usually petioled; **cauline leaves** 1–3 (4) in addition to a **basal leaf; leaflets** oval to reniform, with acute to truncate or slightly cordate bases (4) 5–15 lobed, with sharp to broadly crenate **lobes** (teeth), (leaflets) 0.3–3.2 (4.8) cm in diameter, glabrous, sometimes glaucous, without prominent veins below, pale gray-green to purplish (especially when young); **petioles** stout, glabrous, 1–20 cm long, ribbed, strongly sheathing at their bases (often auriculate); **stems** glabrous, ribbed, up to 1 m tall, from a stout, erect **caudex** 0.3–1.1 cm in diameter; **rhizome** (if present) laterally connecting the erect caudices; **roots** tough, fibrous. (2n = 42)

Importance: This species is sometimes grown in shady garden locations and along borders for its purplish, early foliage which looks much like Columbine.

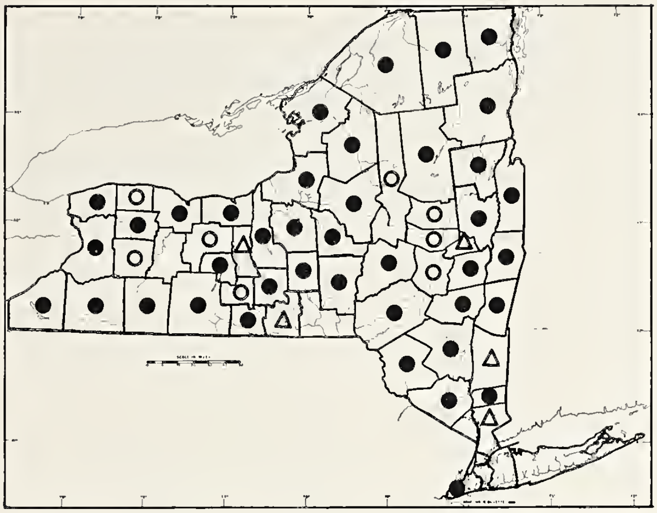
Waifs: *Thalictrum aquilegiafolium* L. has been collected at the border of woods in Bronx Park.

18. COPTIS

Common Names: Goldthread, Canker-root

Authority: Linnaeus, Species Pl., p. 558, 1753

A genus of about 10 north-temperate and arctic species. Our native species is the only one in the northeast United States; however, it ranges to Asia and has relatives in the western states and Alaska, such as *Coptis laciniata* Gray and *C. aspleniifolia* Salisb. The plants have been used medicinally and grown ornamentally.



1. *Coptis trifolia* (L.) Salisb.

Common Names: Goldthread, Canker-root, Goldenthread

Type Description: Linnaeus, Species Pl., p. 558, 1753

Synonyms: *Helleborus trifolius* L., *Coptis groenlandica* (Oed.) Fern., *C. trifolia* var. *groenlandica* (Oed.) Fass., *C. trifolia* ssp. *groenlandica* (Oed.) Hult., *Anemone groenlandica* Oed., *Helleborus pumilus* Salisb., *Chrysa borealis* Raf., *Isopyrum trifolium* (L.) Britt.

Origin: Ancient Arctotertiary Forest

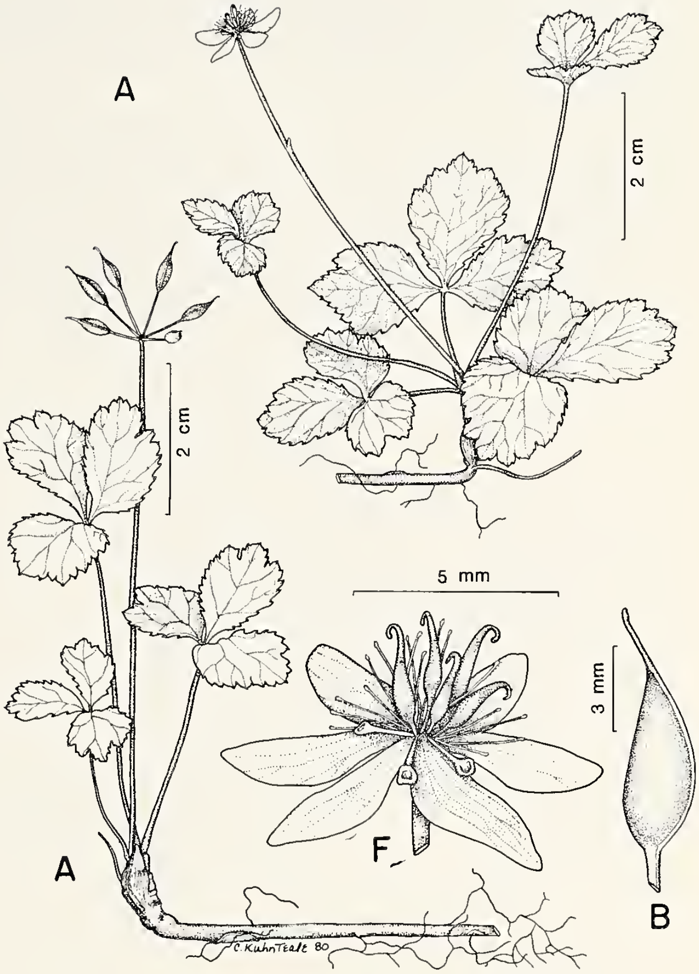
Habitats: Wet woods, bogs, swamps, mossy places and rotting logs

Habit: Scapose, rhizomatous, perennial herbs

Flowering: April–May

Fruiting: May–September

General Distribution: Eastern U. S. and Canada, south to the Appalachians, scattered to western Canada, Alaska, Japan and Siberia



Description: Plants with **bisexual** flowers; **stigma** 1 per ovary, linear, on the abaxial surface of the slightly curved **style**; style 1.5–2.0 mm long; **ovaries** 3–9, free, 1.5–2.0 mm long, each on a 2 mm stipe, becoming a 4–8 seeded **follicle**; follicles fusiform, smooth, keeled on the abaxial side, 5–9 mm long, each borne on a 4–8 mm **stipe** and beaked by the **persistent style** (2.5–4.0 mm), hooked in the area of the stigma; **seeds** ellipsoid, shiny, red-brown, ca 1 mm long; **stamens** about 20–30, 3–4 mm long, in a spiral; **filaments** thread-like; **anthers** globose, ca 0.5 mm long; **staminodia** 5–7, clavate-spatulate, 2.5–3.0 mm long, each with a nectary borne in its expanded, connate tip; **petals** absent (or represented by the staminodia); **sepals** 5–7, petaloid, white, 5–9 mm long, 1–4 mm broad, spatulate, oblanceolate or elliptic-lanceolate, the apex acute to obtuse or rounded, the base gradually narrowed (clawed in the west and Asia); **scapes** one to several per plant, 4–11 cm tall, slender, glabrous, each with a **single flower** and usually with a lanceolate **scale** ca 1.5 mm long, 1–3 cm below the flower; **leaves** basal, ternately compound; **leaflets** 8–28 mm broad evergreen, lustrous, dark green above, with a few simple hairs along the veins of the paler under surfaces, cuneate-obovate, sharply toothed, often with slightly cut or lobed margins, sometimes obscurely ternate; **petiolules** up to 1 mm long; **petioles** 3–11 cm long, glabrous except for some hairs at the juncture of the blade, caniculate-sheathing at the base, enclosing a golden, mitre-like **bud** with one simple and one bifid lobe; **stipules** sheathing, chartaceous, brown, the older ones subtending the remains of previous years growth; **stems** short, often subterrainian caudices which develop at intervals along slender, golden-yellow **rhizomes**; rhizomes with **scales** at intervals, each of which accompanies a filiform **root**. (2n = 18)

Infraspecific Variation: Because the sepals are gradually narrowed at the base rather than attenuated into a claw, the eastern Canadian and U. S. plants have been called a subspecies, variety or full species with the epithet *groenlandica*.

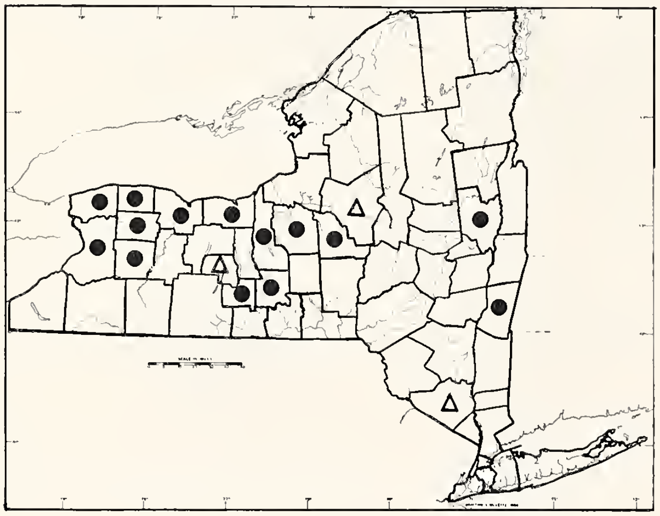
Importance: The rhizomes and roots contain Berberine, and have been used in bitter tonics to promote digestion, aid dyspepsia and strengthen the viscera. In New England the extract has been applied externally to combat thrush, the childhood disease.

19. HYDRASTIS

Common Names: Golden-seal, Orangeroot, Yellow Puccoon

Authority: Ellis, in Linnaeus, Syst. ed. 10, p. 1088, 1759

A genus of two species, one from eastern U. S. and southern Canada, and the other from Asia, showing the classic pattern of Arctotertiary disjunction, *Hydrastis* is exploited for the roots which are used in the pharmaceutical trade.



1. *Hydrastis canadensis* L.

Common Names: Golden-seal, Orangeroot, Yellow Puccoon, "Turmeric"

Type Description: Linnaeus, Syst. ed. 10, p. 1088, 1759

Synonyms: *Warnera canadensis* (L.) Mill., *W. diphylla* Raf., *W. tinctoria* Raf.

Origin: Ancient, Arctotertiary Forest

Habitats: Rich woodlands, often in humus

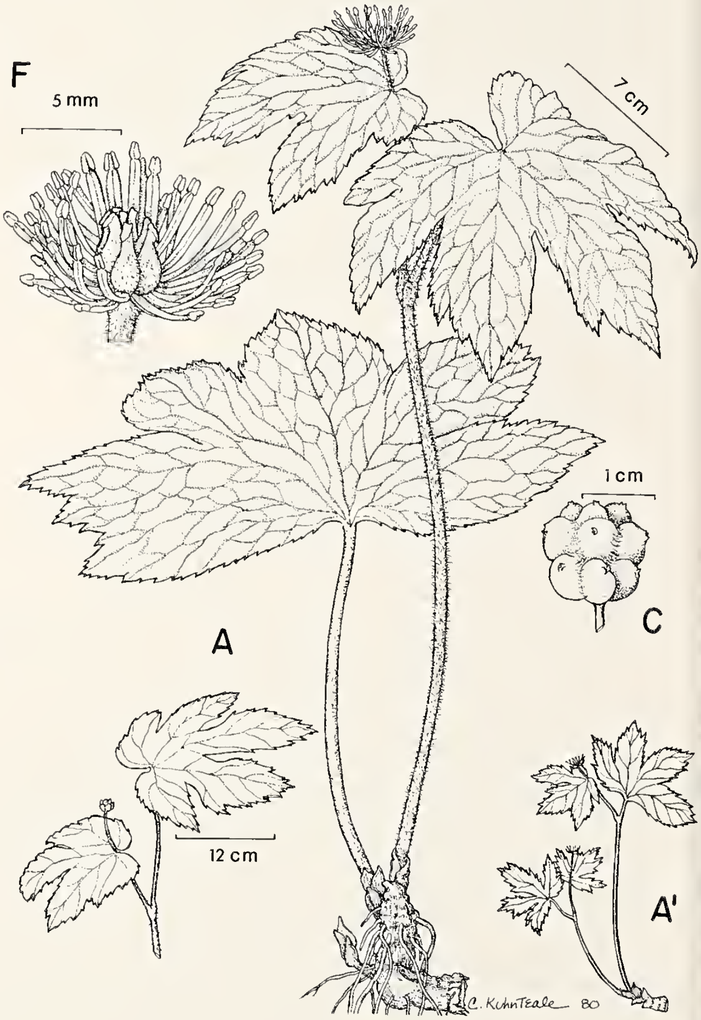
Habit: Erect, perennial herbs

Flowering: April–May

Fruiting: June–August

General Distribution: Vermont to Minnesota and Nebraska, south to Arkansas and Georgia (much-depleted throughout; extirpated in Kansas)

Rarity Status: Listed by the Smithsonian Institute as threatened; commercially vulnerable



Description: Plants with **bisexual** flowers; **stigma** 1 per ovary, flat, 2-lobed; **style** 1 per ovary, short; **ovaries** 5–12 (15) per flower, ca 3 mm long, spindle-shaped, with hispid bases, each bearing two **ovules;** each ovary becoming an oblong crimson to dark red **berry;** berries borne in a dense, fused **head,** 0.8–2.1 cm in diameter, each berry 5–8 mm long; **seeds** 1–2 per berry, shiny, ebony at maturity 2.5–4.5 mm long, with flattened sides and a small keel; **stamens** 4–8 mm long, with linear to inflated, creamy **filaments**; these giving the main color to the **flower; perianth** parts early-deciduous, 3 in number, pale, in a single whorl and inconspicuous when present; **flower** one per shoot 1.0–1.8 cm wide, on a densely hispid **peduncle** which arises at the base of a sessile leaf; **leaves** usually 3 per individual stem, morphologically similar, but each different in its disposition; **sessile cauline leaf** subtending the peduncle (which is merely a continuation of the stem), 3–5 palmately lobed and veined, with large and small, irregular dentations, densely pilose-hispid throughout when young, mostly remaining so at maturity, especially along major veins, (leaf) 2–7 cm in diameter at anthesis, becoming up to 15 cm wide at maturity, but consistently smaller than petioled leaves; **petioled cauline leaf** like the sessile one, but larger, becoming 12–20 cm wide at maturity; **cauline leaf petiole** 0.5–9.5 cm long, hispid, clasping at base; **basal leaf** like the cauline ones, but larger, reaching 26 cm in diameter at maximum; **basal leaf petiole** 5–28 cm long, often extending its leaf to the level of the cauline ones; **stem** fluted, pilose when young, becoming virtually glabrous with age, up to 36 cm in height; 1-several clasping, translucent **scales** subtend the stem where it joins the **rhizome** at ground level; **rhizome** yellowish, knotty-tuberous, clumped, with tough, fibrous **roots.** (2n = 26)

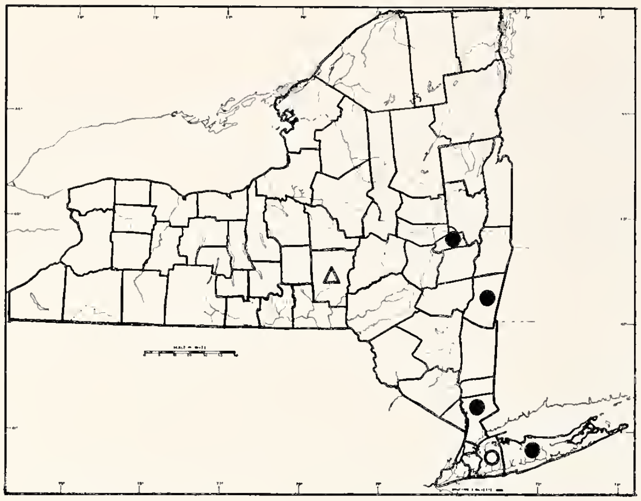
Infraspecific Variation: The basal leaf is sometimes absent; occasionally a second, smaller shoot with two cauline leaves and a flower arises from the point where the basal leaf would be expected.

Importance: The powdered rhizome has been used in commercial preparations for gastrointestinal inflammation and hemorrhoids. Its collection for this purpose is undoubtedly a major factor in the plant's present rarity, as it was once more common under moderately shady, forest conditions. Settlers in the eastern U. S. found the native people using tonic made from the rhizome for stomach and liver ailments, sore eyes and as a yellow dye for their faces. The product did not become an article of commerce until the 1850s, but has since been listed as: treatment for inflamed mucous membranes (Catarrh), antibiotic against protozoa and broad-spectrum bacteria, laxative, hemostatic, alterative, astringent and detergent. The major active antibiotic ingredient is the 3.5–4% Berberine (Hydrastine), an alkaloid known from other plants as well; rhizomes also contain Canadine, resins, starch, sugar, fats and a volatile oil which gives them a characteristic odor..Golden-seal is not easily cultivated, and the rhizomes lose much weight in drying; these factors contribute to the soaring price per pound in recent years. Remaining populations are severely threatened and require management, or the species will surely become endangered.

20. XANTHORHIZA

Common Name: Yellowroot

Authority: Marsh., Arb. Amer., p. 168, 1785.
A genus with a single species, endemic to the Appalachians of the southeastern United States with outlying populations in Florida and Pennsylvania. It is an escape from cultivation in the midwest and northward to New York State and Connecticut. It was reported as native to New York in the early 19th century but no specimen has been found.



1. *Xanthorhiza simplicissima* Marsh.

Common Names: Yellowroot, Yellow-wood, Shrub Yellowroot

Type Description: Marsh., Arb. Amer., p. 168, 1785

Synonyms: *Zanthorhiza apiifolia* L'Her

Origin: North America; early Arctotertiary

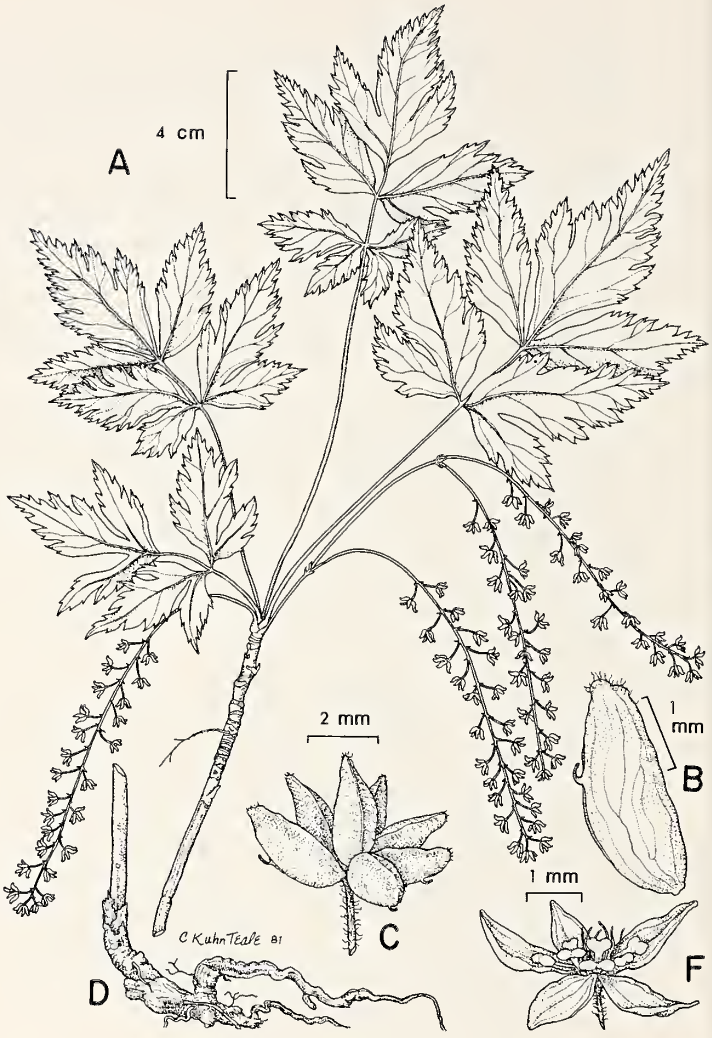
Habitats: Woods, thickets and moist ravines; escaping cultivation near nurseries

Habit: Erect, perennial subshrubs

Flowering: April–May

Fruiting: May–July

General Distribution: Southern Pennsylvania, along the Appalachians to Alabama (western Florida). Reported native to Chenango Co., N. Y. (Torrey Flora), now known as an escape, Columbia Co. and northern Long Island



Description: Plants with **bisexual** flowers or **polygamous**; **stigma** 1 per ovary, at the tip of slender, recurved **style** ca 0.5 mm long; **ovaries** 5–9 (15), free, about 0.5 mm long, teardrop shaped, each with 2 pendulous **ovules**, one of which often aborts; each **ovary** becoming an inflated **follicle** in fruit; follicles 5–10 in a loose cluster, pale brown, each 4–6 mm long, obliquely oblong, the adaxial side with a pubescent suture which extends around the **saccate terminal lobe** to the **persistent style** on the abaxial side; **style** recurved, tail-like, apparently serving as a stop for the suture upon dehiscence; seed 1 (rarely 2) per follicle, distal; **stamens** 5 (10), 4-celled, with short, attenuated **filaments**, interior to 5 larger **staminodes**; staminodes 2-lobed, nectariferous, on flattened stalks, alternating with perianth lobes; **perianth** of 5 free **sepals** which are attenuated at the bases and have acute tips, reddish to purple-brown with yellow tinges, each one 2–3 mm long, making the flower 6–7 mm in diameter; **pedicels** 2–4 mm long, villous; **inflorescences** numerous simple to compound racemes, 3–12 (16) cm long, drooping and spreading on slender, villous axes, each bearing 15–35 flowers or more; **bracts** linear-lanceolate, about 1 mm long; **leaves** pinnately compound; **leaflets** 5 (7), ovate (often distorted), attenuated at bases, variously cut and toothed, the lower 2 often incised to near their bases, 5–9 cm long at maturity, puberulent along the veins; **petioles** 5–15 cm long at maturity, sparsely villous; **bud** scales leathery, oblong, puberulent and reflexing, much like those of *Sassafras*, enclosing both inflorescences and leaves which appear together in spring; **leaf scars** irregular; **bud scars** prominent, ringing the stem; **bark** reddish-yellow to brown, peeling readily, revealing the **yellow wood**; **stem** tough, woody, up to 5 dm tall, from a fibrous, yellow **rootstock.** (2n = 36)

Importance: An extract of the bitter, yellow root was used by Catawba Indians and early settlers as a treatment for ulcerated stomach and other gastrointestinal disorders, as well as for sore throats and colds. Roots were also used by Indians as a source of yellow dye. Plants are cultivated as a ground cover, and readily escape in suitable climates to form extensive colonies.

APPENDIX I

FUNGI ASSOCIATED WITH PLANT SPECIES IN THIS TREATMENT

To be included on this list, a fungus must occur on a species in this treatment somewhere in the United States. If a fungus occurs in New York State and has not as yet been recorded on a host covered in this treatment, but has been collected on such a host in some other state, it is marked with a single asterisk (*).

Abbreviations of states indicate a literature citation for each. Double asterisks (**) indicate that a herbarium specimen with New York State host information has been seen.

CHYTRIDIALES

Physoderma sp., on *Ranunculus acris* (Mich.)

Synchytrium anemones (DC. ex Fries) Woron., on *Anemone cylindrica* (Iowa, Minn.), on *Anemone quinquefolia* (Del., Iowa, Mass., Mich., N.Y.**, Vt., Wisc.), on *Anemone virginiana* (Vt.)

Synchytrium aureum Schröt. *, on *Caltha palustris* (Wisc.), on *Ranunculus repens* (Ill.)

Synchytrium cinnamomeum J. J. Davis, on *Ranunculus hispidus* var. *caricetorum* (Wisc.), on *Ranunculus* sp. (Wisc.)

PERONOSPORALES

Peronospora hiemalis Gäum. (= *Peronospora ficariae* Tul. ex de Bary in part), on *Ranunculus acris* (Mass., N.Y.**)

Peronospora pensylvanica Gäum (=*Peronospora ficariae* Tul. ex de Bary in part), on *Ranunuculus pensylvanica* (N.Y.**)

Peronospora ranunculi Gäum. (= *Peronospora ficariae* Tul. ex de Bary in part), on *Ranunculus acris* **, on *Ranunculus bulbosus* (Mass.), on *Ranunculus pensylvanicus* **, on *Ranunculus repens*** (Mich.)

Phytopthora thalictri G. Wils. & J. J. Davis, on *Thalictrum dasycarpum* Wisc., on *Thalictrum pubescens* (Conn., N.Y., Wisc.)

Plasmopara pygmaea (Unger) Schröt., on *Aconitum* sp. (Alaska), on *Anemone canadensis (N.Y.*** to Ill., N. Dak.), on *Anemone quinquefolia* **(Mass. to Ill., Wisc.), on *Anemone virginiana* (Ill., N.Y.**, Wisc.) on *Hepatica nobilis* (Iowa, Wisc.), on *Hepatica nobilis* var. *acuta* **, on *Hepatica nobilis* var *obtusa* **

Plasmorpara pygmaea (Unger) Schröt. var. *fusca* (Peck) J. J. Davis, on *Hepatica nobilis* (N.Y., Wisc.)

Pythium aphanidermatum (Edson) Fitzp., on *Consolida ambigua* (Va.)

Pythium ultimum Trow, on *Consolida ambigua* (Calif., N.Y.)

ERYSIPHALES

Erysiphe aquilegiae DC. ex Mérat, on *Thalictrum* sp. (Minn.)

Erysiphe polygoni DC., on *Aconitum* sp. (N.Y., Tex., W. Va.), on *Anemone canadensis* (Ill., Iowa, N.J., N.Y.**, N. Dak.. Wisc.), on *Anemone virginiana* (Iowa, Mich., Minn.), on *Anemonella thalictroides* (Iowa), on *Aquilegia canadensis* (Ill., Ind., Iowa, N.Y., Ohio, Pa., Wisc.), on *Aquilegia vulgaris* (N.J.), on *Caltha palustris* (Mich., N.Y.**, Ohio, Wisc.), on *Clematis virginiana* (Maine to Ga.), on *Consolida ambigua* (Calif.), on *Ranunculus abortivus* **, on *Ranunculus acris* **, *Ranunculus flabellaris* and *Ranunculus repens* (eastern and central U. S.), on *Thalictrum dasycarpum* and *Thalictrum pubescens* ** (eastern and central U.S.)

Sphaerotheca humuli (DC.) Burr., on *Consolida ambigua* (Calif.)

SPHAERIALES

Diaporthe arctii (Lasch) Nits., on *Consolida ambigua* (Md., N. C., N. Y., Ohio, Pa.)

Leptospheria vagabunda Sacc., on *Clematis virginiana* (N.Y.**)

Leptospheria sp., [near *Leptospheria ogiliviensis* (Berk. & Br.) Ces. & de Not (= *Ophiobolus subolivaceus* Peck)], on *Thalictrum pubescens*

HELOTIALES

Helotium scutula (Pers. ex Fries) Karst., on *Thalictrum* sp. (Minn.)

Leptotrochila ranunculi (Fries) Schuepp [= *Fabraea ranunculi* (Fries) Karst.], on *Ranunculus acris* (N.Y.), on *Ranunculus hispidus* var. *caricetorum* (Wisc.), on *Ranunculus* sp. (N.Y., Wisc.)

Mollisiopsis subcinerea Rehm, on dead stems of *Thalictrum* sp. (N.Y.)

Pseudopeziza calthae (Phillips) Massee (= *Fabraea rousseauana* Sacc. & Bomm.), on *Caltha palustris* (Wisc.)

Pseudopeziza singularis (Peck) Davis, on living leaves of *Ranunculus* sp. (N.Y.)

Pyrenopeziza thalictri (Peck) Sacc., on overwintered stems of *Thalictrum* sp. (N.Y. **)

Sclerotinia sclerotiorum (Libert) de Bary, on *Aconitum* sp. (Colo.), on *Aquilegia vulgaris* (Del., Ohio, Pa.) on *Consolida ambigua* (Mo., Tex.)

PLEOSPORALES

Physalospora obtusa (Schw.) Cooke (= *Botryosphaeria* ?, *Sphaeropsis clematidis* Dearn. & House, *Sphaeropsis malorum* Peck non Berk., *Sphaeropsis punctata* Dearn. & House, *Sphaeropsis seriata* Peck), on *Clematis* sp. (N.Y.)

DOTHIDEALES

Mycosphaerella coptis (Schw.) House [= *Sphaeria coptis* Schw., *Sphaerella coptis* (Schw.) Farlow, *Laestadia coptis* (Schw.) Ellis & Everh.], on *Coptis trifolia* (Maine, N.Y., Vt.)

Mycosphaerella hypsicola (Ellis & Everh.) Lindau, *Trollius laxus* (Colo.)

Mycosphaerella punctata Dearn. & House, *Thalictrum pubescens* **

Mycosphaerella ranunculi (Karst.) Lindau, *Ranunculus* sp. (N.H.)

Mycosphaerella thalictri (Ellis & Everh.) Lindau, on *Thalictrum dasycarpum* (Iowa, Wisc.), on *Thalictrum dioicum* (Iowa, N.J., N.Y., Vt.), on *Thalictrum pubescens* (Iowa, N.Y.**, Wisc.), on *Thalictrum* sp. (Iowa, Pa.)

USTILAGINALES

Doassansia ranunculina J. J. Davis, on *Ranunculus flabellaris* (Ind., Md., Wisc.)

Entyloma ficariae (Cornu & Roze) Fisch. v. Waldh. [= *Entyloma ranunculi* (Bonord.) Schröt.], on *Anemone quinquefolia* (Wisc.), on *Ranunculus flabellaris* (Ind.), on *Ranunculus pensylvanicus* (Wisc.), on *Ranunculus repens* (Va.), on *Ranunculus hispidus* var. *caricetorum* (Maine), on *Thalictrum dasycarpum* (Ill., Wisc.)

Entyloma microsporum (Unger) Schröt., on *Ranunculus fascicularis* (Wisc.), on *Ranunculus hispidus* var. *caricetorum* (Ill., Iowa, Maine, N.Y.**, Wisc.), on *Ranunculus hispidus* var. *nitidus* (Ind.), on *Ranunculus pensylvanicus* (Wisc.)

Entyloma thalictri Schröt., on *Thalictrum dasycarpum* (Ill., Wisc.), on *Thalictrum dioicum* (Ind., Wisc.), on *Thalictrum pubescens* (Conn., N.H.), on *Thalictrum revolutum* (N.Y.)

Urocystis anemones (Pers.) Wint., on *Anemone canadensis* (Minn., N. Y., Wisc.), on *Anemone cylindrica* (Colo.), on *Anemone quinquefolia* ** (Maine to Del., Iowa, Mich., Minn., Wisc.), on *Anemone virginiana* (Ind., Iowa, N. Y. **, Tex.), on *Anemone virginiana* var. *alba* (N. Y.), on *Anemonella thalictroides* (Iowa, Minn., N. Y. **), on *Hepatica nobilis* var. *acuta* (Ill., Ind., Iowa, Maine, Minn., N. Y. **, Ohio, Pa., Wisc.), on *Hepatica nobilis* var. *obtusa* (N. Y. **, Va.), on *Ranunculus hispidus* var. *caricetorum* (Mo.), on *Trollius laxus* (N. Y.)

Urocystis carcinodes (Berk. & Curtis) Fisch. v. Waldh., on *Aconitum* sp. (Utah), on *Actaea pachypoda* (Pa., W. Va.), on *Actaea spicata* ssp. *rubra* (Idaho, Utah), on *Cimicifuga racemosa* (N. C., N. Y. **, Ohio, Pa., Tenn., Va.)

Urocystis sorosporioides Körn., on *Aconitum* sp. (Utah), on *Anemonella thalictroides* (Iowa, N. Y.), on *Thalictrum dasycarpum* (Mass.), on *Thalictrum pubescens* (N. Y. **), on *Thalictrum revolutum* (Mass., N. Y. **)

UREDINALES

Puccinia andina Diet. & Neger, (III) on *Ranunculus hispidus* var. *caricetorum,* (III.) on *Ranunculus hispidus* var. *nitidus* (Ind., N. Y. **)

Puccinia anemones-virginianae Schw., (III) on *Anemone canadensis* (Iowa, Mich., N. Y.), on *Anemone cylindrica* ** (Maine to Miss., Okla., N. Dak.), on *Anemone virginica* ** (Vt. to N. D., N. C. to Mo.), on *Anemone virginiana* var. *alba* (Maine, Vt.)

Puccinia calthae (Grev.) Link, (0, I, II, III) on *Caltha palustris* (Ind., Iowa, Mich., N. J., N. Y. **, N. D., S. D., Wash., Wisc.)

Puccinia calthaecola Schröt., (0, I, II, III) on *Caltha palustris* (Iowa, Mich., Minn., N. Y., Wisc.)

Puccinia eatoniae Arth. var. *ranunculi* Mains, (0, I) on *Ranunculus abortivus* (Conn., Del., Ill., Ind., Iowa, Mich., Miss., Mo., N. Y. ** , N. C., N. D., Ohio, Pa., S. C., S. D., W. Va., Wisc.), on *Ranunculus allegheniensis* ***, on *Ranunculus micranthus* (W. Va.)

Puccinia gigantispora Bubák, (0, I, III) on *Anemone cylindrica, Anemone multifida* (Colo., Ill., N. Dak., Wisc.)

Puccinia magnusiana Körn., (0, I) on *Anemone canadensis* (Iowa, Kans., Nebr., N. Y., N. D., S. D., Wisc.). II and III on *Phragmites australis.*

Puccinia recondita Roberge ex Desm. [= *Puccinia rubigo-vera* (DC.) Wint.] 0, I on Ranunculaceous hosts — II, III on various grasses. on *Aconitum* (Alaska, Colo.), *Actaea pachypoda* **, *Actaea spicata* ssp. *rubra* (N. Y. ** to Va., Ill., Minn.), on *Anemone canadensis* **, *Anemone cylindrica* **, *Anemone quinquefolia* **, *Anemone virginiana* (N. Y. ** to Tex., Colo., Mont.), on *Anemonella thalictroides* (Ind., Iowa, Mo.), *Cimicifuga racemosa* **, *Clematis virginiana* ** (eastern U. S.): on *Ranunculus acris, Ranunculus cymbalaria, Ranunculus hispidus* var. *caricetorum* **, *Ranunculus repens* (Wisc., to Tex., Calif., Wash., Alaska); on *Thalictrum dasycarpum, Thalictrum dioicum* **, *Thalictrum pubescens* **, *Thalictrum revolutum* ** (N.E. and N. central U. S.)

Tranzschelia anemones (Pers.) Nannf. ex Lundell & Nannf. [= *Tranzschelia fusca* (Pers.) Wint., *Tranzschelia suffusca* (Holw.) Ruth]. 0, III on *Anemone quinquefolia* ** (Mass. to Va., Ill., Minn.), on *Thalictrum pubescens* **

Tranzschelia pruni-spinosae (Pers.) Diet., (0, I on ranunculaceous hosts — II, III on *Prunus.*), on *Anemone quinquefolia* ** (Vt. to Ala., Iowa, Wisc.), on *Hepatica nobilis* ** (Mass. to Md., Minn., and Tex.), on *Thalictrum dasycarpum* (Colo, Iowa, Kans., N. Dak. Nebr., S. Dak.), on *Thalictrum pubescens* (Ohio)

Tranzschelia thalictri (Chev.) Diet., 0, III on *Thalictrum dasycarpum, Thalictrum dioicum* **, *Thalictrum pubescens* **, *Thalictrum revolutum* ** (Eastern & Central U. S.)

Uromyces dactylidis Otth, 0, I on *Ranunculus repens* (Mass.)

Uromyces lycoctoni (Kalchbr.) Trotter, 0, I, II, III on *Aconitum* sp. (Calif., Colo., Tex., Utah, Wyo.)

TULASNELLALES

Ceratobasidium anceps (Bres. & Syd.) H. Jacks., on *Ranunculus hispidus* var. *caricetorum* (Wisc.)

MONILIALES

Alternaria sp., on *Hydrastis canadensis* (Mich., N. Y., Ohio), on *Aconitum noveboracense* **

Botrytis cinerea Pers. ex Fries, on *Aconitum noveboracense* **, on *Aquilegia vulgaris* (Va.), on *Consolida ambigua* (N. Y.), on *Ranunculus* sp. (N. Y., Wisc.)

Botrytis sp., on *Hydrastis canadensis* (Conn. to N. C., Ind.)

Cercospora aquilegiae Kellerm. & Swing., on *Aquilegia canadensis* (Kans.), on *Aquilegia vulgaris* (Kans.)

Cercospora calthae Peck & G. W. Clinton, a name of unknown origin on *Caltha palustris* (Wisc.)

Cercospora caulophyli Peck, on *Anemonella thalictroides* Mo.

Cercospora filiformis J. J. Davis, on *Thalictrum dasycarpum* (Wisc.)

Cercospora fingens J. J. Davis, on *Thalictrum dasycarpum* (Wisc.), on *Thalictrum dioicum* (Wisc.), on *Thalictrum* sp. (Ill.)

Cercospora ranunculi Ellis & Holw., on *Ranunculus hispidus* var. *caricetorum* (Wisc.), on *Ranunculus repens* (Wisc.)

Cercospora squalidula Peck, on *Clematis virginiana* (Ala., La., Mass., N. C., Nebr., N. Y. **, Wisc.)

Didymaria didyma (Unger) Pound, on *Anemone canadensis* (Iowa, Mich., Wisc.), on *Anemone cylindrica* (Iowa, Mich., Wisc.), on *Anemone virginiana* (Iowa, Mich., Wisc.), on *Ranunculus abortivus* **, on *Ranunculus acris* ** (Wisc.), on *Ranunculus hispidus* var. *caricetorum* (Ind., Iowa, Mich., N. Y. **, Wisc.), on *Ranunculus hispidus* var. *nitidus* (Miss.), on *Ranunculus repens* (Ill., Mass., Wisc.)

Ectostroma afflatum (Schw.) Fries, on *Cimicifuga racemosa* (Va.)

Fusarium sp., on *Hydrastis canadensis* (Ill., N. Y., Ohio, Wash.)

Ovularia decipiens Sacc., on *Ranunculus acris* N. Y. **, on *Ranunculus repens* (Tex.), on *Ranunculus* sp. (N. Y.)

Phymatotrichum omnivorum (Shear) Dug., on *Aconitum* sp. (Tex.), on *Aquilegia canadensis* (Tex.), on *Consolida ambigua* (Tex.), on *Hydrastis canadensis* (Tex.), on *Ranunculus repens* (Tex.)

Ramularia actaeae Ellis & Hollw., on *Actaea pachypoda* (Iowa, Vt.), on *Actaea spicata* ssp. *rubra* (Colo., N. M., Wisc.)

Ramularia aequivoca (Ces.) Sacc. (= *Ramularia gibba* Fuckel), on *Ranunculus abortivus* (Wisc.), on *Ranunculus hispidus* var. *caricetorum* (Ill., Iowa, Wisc.), on *Ranunculus repens* (Ill., Iowa, Wisc.), on *Ranunculus* sp. (Ill., Iowa, Wisc.) Conidial state of *Stigmatea ranunculi* Fries

Ramularia calthae Liro, on *Caltha palustris* (N. Y. **, Wisc.)

Ramularia ranunculi Peck, on *Anemone canadensis* N. Y. **, on *Anemone cylindrica* (Wisc.), on *Ranunculus acris* (Maine, N. Y. **, Vt.), on *Ranunculus hispidus* var. *caricetorum* **, on *Ranunculus hispidus* var. *nitidus* (Ind., Miss.), on *Ranunculus recurvatus* **, on *Ranunculus* sp. (Ind., Iowa, Md., N. Y., Vt.)

Septocylindrium ranunculi Peck, on *Ranunculus abortivus* **, on *Ranunculus abortivus* var. *eucyclus* **, on *Ranunculus acris* (N. Y.), on *Ranunculus* sp. (Ill., N. Y., Wisc.)

Stemphylium lancipes (Ellis & Everh.) Simmons (= *Alternaria lancipes* Ellis & Everh.), on *Aquilegia* sp. (Kans.)

Verticillium albo-atrum Reinke & Berth., on *Aconitum* sp. (Mass., N. J., N. Y., Ohio), on *Consolida ambigua* (N. Y.)

SPHAEROPSIDALES

Ascochyta actaeae (Bres.) J. J. Davis [= *Actinonema actaeae* Allesch, *Marssonina actaeae* (Bres.) Magn.], on *Actaea spicata* ssp. *rubra* (Wisc.), on *Cimicifuga racemosa* (Conn., N. Y.)

Ascochyta aquilegiae (Rabenh.) Höhn [= *Marssonia aquilegiae* Rabenh.) Lind, *Phyllosticta aquilegiae* Roum. & Pat, *Actinonema aquilegiae* Grove, *Phyllosticta aquilegiae* Tehon & Daniels], on *Aquilegia canadensis* (Ill., Wisc.), on *Aquilegia vulgaris* (Conn., Iowa, Md., N. J., N. Y., Pa., Wisc.)

Ascochyta clematidina Thüm. forma *thalictri* J. J. Davis, on *Thalictrum dasycarpum* (WISC.), on *Thalictrum dioicum* (Wisc.)

Ascochyta clematidina Thüm ex Gloyer, on *Clematis virginiana* (Miss., N. J., N. Y. **, Ohio, W. Va., Wisc.)

Ascochyta infuscans Ellis & Everh., on *Ranunculus* sp. (Wisc.), on cultivated *Trollius* sp. (N. Y.)

Coniothyrium hellebori Cooke & Massee, on cultivated *Helleborus* sp. (Md., N. C., N. Y., Oreg.)

Diplodia herbarum Lév., on *Thalictrum pubescens* **

Diplodia hortensis Sacc., on *Clematis* sp. (Mich., N. Y.)

Diplodia thalictri Ellis & Dearn., on *Thalictrum pubescens* **

Diplodia thalictroides (Syd.) Allesch., on *Clematis* sp. (Mich., N. Y.)

Diplodina delphinii Laskaris, on *Consolida ambigua* (Calif.)

Hendersonia hortilecta Fairm., on *Clematis* sp. (N. Y.)

Phleospora anemones Ellis & Kellerm. (See *Septoria punicea–Sphaeropsidales*)

Phoma anemone C. Kauffm., on *Anemone virginiana* (Fla.)

Phoma spermoides Dearn., on *Thalictrum pubescens* (N. Y.) on *Thalictrum dasycarpum* (Pa.)

Phoma sp., on *Aquilegia vulgaris* (Pa.)

Phomopsis trollii Fairm., on cultivated *Trollius* sp. (N. Y.)

Phyllosticta clematidis Ellis & Dearn., on *Clematis* sp. (Va.)

Phyllosticta anemonicola Sacc. & Syd., on *Anemone canadensis* (Ill., Mich., Wisc.), on *Anemone cylindrica* (Ill., Nebr., Wisc.)

Phyllosticta ellisiana Lambotte & Fautr., on *Anemone virginiana* (Vt.)

Phyllosticta trollii Trail, on *Trollius laxus* (Wyo.)

Phyllosticta xanthorhizae Ellis & L. W. Nutt., on *Xanthorhiza simplicissima* (N. C., W. Va.)

Rhabdospora clarkeana Sacc., on *Aquilegia canadensis* (N. Y.)

Septoria anemones Desm., on *Anemone canadensis* (Ill., Iowa), on *Anemone cylindrica* (Wisc.), on *Anemone quinquefolia* (Wisc.), on *Anemone virginiana* (Ill., Iowa, Miss., Mo., Vt., Wisc.)

Septoria aquilegiae Penz. & Sacc., on *Aquilegia canadensis* (Ind., Mich., N. Y. **, Ohio, Vt., Wisc.), on *Aquilegia vulgaris* (Mich., Ohio, Va., Wisc.)

Septoria clematidis Roberge & Desm. (= *Septoria jackmani* Ellis & of N. Y. reports), on *Clematis virginiana* **, on *Clematis* sp. (Wash., Wisc.)

Septoria coptidis Berk & Curtis, on *Coptis trifolia* (Mich., N. Y. **)

Septoria coptidis Berk. & Curtis var. *macrospora* Peck, on *Coptis* trifolia **

Septoria cylindrica Ellis & Everh., on *Anemone cylindrica* (Mont.), on *Anemone virginiana* (Va.)

Septoria delphinella Sacc., on *Consolida ambigua* (Ill.)

Septoria ficarioides Peck, on *Ranunculus cymbalaria* (Nebr.)

Septoria hepaticae Desm., on *Hepatica nobilis* (Mich., N. C.)

Septoria longispora Overh., on *Aquilegia canadensis* (Pa.)

Septoria polaris P. Karst., on *Ranunculus hispidus* var. *caricetorum* (Wisc.), on *Ranunculus rhomboideus* (Wisc.)

Septoria punicea J. J. Davis (= *Phleospora anemones* Ellis & Kellerm.), on *Anemone cylindrica* (Iowa, Nebr., N. Y. **), on *Anemone virginiana* (Mass., Mich., Wisc.)

Septoria thalictri Ellis & Everh., on *Thalictrum dasycarpum* (conidial state of *Mycosphaerella thalictri?*)

Septoria sp., on *Ranunculus acris* (Pa.)

Sphaeropsis clematidis Dearn. & House (= *Otthia clematidis* Earle?), see *Physalospora obtusa* (Schw.) Cooke in the *Pleosporales*

Sphaeropsis thalictri Ellis & Fairm., on *Thalictrum* sp. (N. Y.)

MELANCONIALES

Colletotrichum dematium (Pers. ex Fries) Grove, on *Coptis trifolia* (Mass.)

Colletotrichum hepaticae Peck, on *Hepatica nobilis* var. *acuta* **

Cylindrosporium clematidis Ellis & Everh., on *Clematis virginiana* (Ala., Conn., Del., Ind., Mich., Miss., N. Y. **, Wisc.)

Cylindrosporium ficariae Berk., on *Ranunculus* sp. (Wash.)

Cylindrosporium montenegrinum Bubák, on *Trollius laxus* (Wyo.)

Cylindrosporium thalictri Ellis & Everh.) J. J. Davis, on *Thalictrum dasycarpum* (Ind., Kans., Wisc.), on *Thalictrum dioicum* (Wisc.)

Cylindrosporium sp., on *Caltha palustris* (N. Y.)

Gloeosporium thalictri J. J. Davis, on *Thalictrum dasycarpum* (Wisc.)

Gloeosporium sp., on cultivated *Helleborus* sp. (N. J.)

Vermicularia coptina Peck, on *Coptis trifolia* (N. Y. **)

MYCELIA STERILIA

Rhizoctonia solani Kühn, on cultivated *Aconitum* sp. (Conn., N. J.), on *Aquilegia vulgaris* (Ill.), on *Hydrastis canadensis* (N. C.)

Sclerotium delphinii Welch (? = *Sclerotium rolfsii* Sacc.), on cultivated *Aconitum* sp. (Conn., Del., Md., Minn., N. J., N. Y.), on *Consolida ambigua* (Mo., Tex.), on cultivated *Helleborus* sp. N.Y. ?)

Sclerotium rolfsii Sacc., on *Consolida ambigua* (Tex.)

APPENDIX II

A List of Some Insects Associated with Plant Species in this Treatment.

THYSANOPTERA

Thripidae
  Frankliniella tritici (Fitch), on *Ranunculus bulbosus*

HEMIPTERA

Miridae
  Halticus intermedius Uhler, on *Clematis virginiana*
  Poecilocapsus lineatus Fabricus, Four-lined Plant Bug on *Aconitum* sp.

HOMOPTERA

Membracidae
  Ceresa basalis Wlk., on *Clematis* sp.
Aphidae
  Aphis craccivora Koch, on *Thalictrum revolutum*
  Aphis rociadae Cockerell, on *Delphinium* (*Consolida*?)
  Kakimia essigi Gillette & Palmer, on *Aquilegia vulgaris*
  Kakimia purpurascens (Oestlund), on *Thalictrum pubescens*, on *Thalictrum revolutum*
  Macrosiphon sp., on *Ranunculus repens*
  Myzus persicae (Sulzer), on *Ranunculus* sp.
  Pergandeidia trirhoda (Walker), on *Aquilegia vulgaris*
  Thecabius populiconduplifolius ? (Cowen), on *Ranunculus repens*

COLEOPTERA

Meloidae
  Epicauta pennsylvanica DeG., Black Blister Beetle, on *Clematis* sp.
Scarabeidae
  Popillia japonica Newn., Japanese Beetle, on *Delphinium* (*Consolida*?), on *Thalictrum pubescens*
Cerambycidae
  Brachysomida bivittata (Say), on flowers of *Anemone* sp.
  Evodinus monticola monticola (Randall), on flowers of *Thalictrum* sp.
  Gaurotes cynipennis (Say), on flowers of *Thalictrum* sp.
  Grammoptera subargentata (Kirby), on flowers of *Ranunculus* sp. and *Thalictrum* sp.
  Pygoleptura nigrella nigrella (Say), on flowers of *Thalictrum* sp.
  Strangalepta vittata (Swederus), on flowers of *Ranunculus* sp.
  Thigonarthris proxima (Say), on flowers of *Thalictrum* sp.

LEPIDOPTERA

Opostegidae
Opostega quadristrigella (Chambers), on ranunculaceous plants
Oecophoridae
  Ethmia fuscipedelia Walsingham, on *Thalictrum* sp.
Aegeriidae
  Alcathoe caudata Harris, on *Clematis* sp.
Thyrididae
  Thyris maculata Harris, on *Clematis* sp.

Papilionidae
- *Papilio cresphontes* Cramer, Giant Swallowtail, on *Thalictrum* sp.

Lycaenidae
- *Lycaenopsis pseudargiolus* (Boisduval & Le Conte), on *Cimicifuga racemosa*

Hesperiidae
- *Erynnis lucilius* (Scudder & Burgess), Columbine Skipper, on *Aquilegia canadensis*

Noctuidae
- *Calpe canadensis* Bethune, on *Thalictrum pubescens*
- *Feltia ducens* Wlk., Dingy Cutworm, on *Delphinium* sp. (*Consolida*?)
- *Heliothis virescens* (Fabricus), Tobacco Budworm, on *Aquilegia canadensis*
- *Papaipema cataphracta* (Grote), Burdock Borer, on *Thalictrum* sp., on *Delphinium* (garden varieties)
- *Papaipema cerussata* (Grote), on *Thalictrum* sp.
- *Papaipema frigida* (Smith), on *Thalictrum pubescens*
- *Papaipema nebris* (Guenee), Common Stalk Borer, on garden *Delphinium*
- *Papaipema purpurifascia* (Grote & Robinson), Columbine Borer, on *Aquilegia canadensis*, on *Aquilegia* sp.
- *Pseudeva purpurigera* (Walker), on *Thalictrum* sp.
- *Pyrrhia umbra* (Hufnagel), on *Aquilegia* sp.

Geometridae
- *Ectropis crepuscularia* (Schiffermuller), on *Aquilegia* sp.

DIPTERA

Cecidomyiidae
- *Dasyneura anemone* Felt, in loose bud gall on *Anemone canadensis*
- *Dasyneura clematidis* Felt, gall on *Clematis virginiana*
- *Neolasioptera clematidis* Felt, gall in *Clematis virginiana* stem
- *Phytophaga socialis* Felt, on *Thalictrum dioicum*
- *Phytophaga thalictri* Felt, on *Thalictrum dioicum*
- *Asphondylia thalictri* Felt, in distorted *Thalictrum* fruits
- *Contarina clematidis* Felt, on *Clematis virginiana*
- *Prodiplosis floricola* Felt, in enlarged *Clematis virginiana* flowers
- *Lestodiplosis clematiflorae* Felt, in unopened flowers of *Clematis virginiana*

Agromyzidae
- *Phytomyza aquilegiae* Hardy, The Columbine Leaf-miner, on *Aquilegia canadensis*, *Aquilegia vulgaris*, and other garden Columbines
- *Phytomyza nitida* Mel., on *Thalictrum* sp.
- *Phytomyza plumiseta* Frost., on *Thalictrum* sp.

HYMENOPTERA

Colletidae
- *Colletes inaequalis* Say, on *Anemone virginiana*
- *Hylaeus affinis* (Smith), on *Clematis* sp.

Andrenidae
- *Andrena alleghaniensis* Viereck, on *Ranunculus* sp.
- *Andrena carlini carlini* Cockerell, on *Anemonella*, *Hepatica*, and *Isopyrum biternatum*
- *Andrena crataegi* Robertson, on *Ranunculus* sp.
- *Andrena cressonii cressonii* Robertson, on *Anemonella thalictroides*, and *Ranunculus* sp.
- *Andrena erigeniae* Robertson, on *Isopyrum biternatum*
- *Andrena erythrogaster* (Ashmead), on *Anemone canadensis*
- *Andrena erythronii* Robertson, on *Hepatica nobilis*
- *Andrena forbesii* Robertson, on *Ranunculus abortivus*
- *Andrena hippotes* Robertson, on *Caltha palustris*, *Ranunculus abortivus*, and*Trollius laxus*
- *Andrena krigiana* Robertson, on *Ranunculus acris*
- *Andrena mandibularis* Robertson, on *Hepatica nobilis*

Andrena melanochroa Cockerell, on *Ranunculus* sp.
Andrena miranda Smith, on *Ranunculus hispidus* var. *caricetorum*
Andrena miserabilis Cresson, on *Hepatica nobilis*, *Isopyrum biternatum*, and *Ranuculus* sp.
Andrena morrisonella Viereck, on *Ranunculus acris*
Andrena nasonii Robertson, on *Ranunculus* sp.
Andrena nigrae Robertson, on *Anemone canadensis*
Andrena nigrihirta (Ashmead), on *Ranunculus* sp.
Andrena personata Robertson, on *Ranunculus abortivus* and *Ranunculus hispidus* var. *caricetorum*
Andrena rugosa Robertson, on *Isopyrum biternatum* and *Hepatica nobilis*
Andrena tridens Robertson, on *Hepatica nobilis*

Halictidae
Augochlora persimilis (Viereck), on *Ranunculus* sp.
Augochlora pura pura (Say), on *Ranunculus* sp.
Augochlorella striata (Provancher), on *Anemone* sp., on *Anemonella thalictroides*, on *Aquilegia* sp., on *Isopyrum biternatum*, on *Nigella damascena*, and on *Ranunculus* sp.

Megachilidae
Osmia conjuncta (Cresson), on *Anemonella thalictroides* and on *Ranunculus* sp.
Osmia georgica Cresson, on *Ranunculus* sp.
Osmia lignaria lignaria Say, on *Ranunculus* sp.
Osmia pumila Cresson, on *Anemonella thalictroides*, on *Isopyrum biternatum*, and on *Ranunculus* sp.
Osmia simillima Smith, on *Ranunculus* sp.
Megachile gemula gemula Cresson, on *Clematis* sp.
Megachile melanophaea melanophaea Smith, on *Ranunculus* sp.
Megachile mendica mendica Cresson, on *Clematis* sp.
Megachile relativa Cresson, on *Ranunculus* sp.

Anthophoridae
Melissodes agilis Cresson, on *Clematis* sp.
Synhalonia hamata (Bradley), on *Delphinium* sp. (*Consolida*?), and on *Ranunculus* sp.

Xylocopidae
Ceratinia calcarata Robertson, on *Caltha palustris*, on *Hepatica nobilis*, on *Isopyrum biternatum*, and on *Ranunculus* sp.
Ceratinia dupla Say, on *Anemonella thalictroides*, on *Delphinium* sp. (*Consolida*?), and on *Ranunculus* sp.
Xylocopa virginica virginica (Linnaeus), on *Aquilegia vulgaris*

Bombidae
Bombus vagans F. Smith, on *Aconitum noveboracense*.

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Contributions Completed to Date[1]

1. Mitchell, Richard S. and J. Kenneth Dean. 1978. Polygonaceae (Buckwheat Family) of New York State. Contributions to a Flora of New York State I. N. Y. State Museum Bull. No. 431, 81 p.

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5. Mitchell, Richard S. and J. Kenneth Dean. 1982. Ranunculaceae (Crowfoot Family) of New York State. Contributions to a Flora of New York State IV. N. Y. State Museum Bull. 446, 100 p.

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A GUIDE TO BASIC TAXONOMIC LITERATURE FOR THE GENERA OF NORTH AMERICAN CHIRONOMIDAE (DIPTERA) — ADULTS, PUPAE, AND LARVAE

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Center for Laboratories and Research
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Abstract. - Simpson, Karl W., Center for Laboratories and Research, New York State Department of Health, Albany, New York 12201. A generic list of North American Chironomidae (Diptera) is presented, based on literature published through the end of 1981. For each genus, references are given (whenever possible) to keys and/or descriptions of adult males, adult females, pupae, and larvae. The compilation includes 170 genera in seven subfamilies: 29 Tanypodinae, 5 Podonominae, 3 Telmatogetoninae, 9 Diamesinae, 4 Prodiamesinae, 66 Orthocladiinae, and 54 Chironominae (14 Tanytarsini, 1 Pseudochironomini, and 39 Chironomini). Subgenera are listed for some (not all) large genera. The generic list is followed by a Literature Cited section and an index.

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INTRODUCTION

The main purpose of this compilation is to provide an updated listing of the genera of North American Chironomidae and to help aquatic biologists quickly locate important taxonomic references for the adults, larvae, and pupae of each genus. The diverse literature and numerous changes in nomenclature often make it difficult for the beginning taxonomist to verify generic names and/or to locate keys and descriptions for the various taxa. In the pages that follow, an attempt is made to cite at least one reference for each genus where keys and/or descriptions for the various stages can be found. References for adults are given first, followed by those for pupae and larvae. In general, the most complete reference for each stage precedes the others. When recent literature is available, older references are omitted, since the purpose of the compilation is to help investigators initiate a literature search. More comprehensive literature listings have been published by Fittkau et al. (1976) and Coffman and Walker (1977).

Due to restrictions of time and space, a great deal of important European literature has not been included. A thorough literature search for most North American genera usually will include some European articles. References given in parentheses are in German; these are cited when they contain substantially more information than is available in the English literature. For a listing of basic taxonomic literature for the European fauna, consult Reiss and Fittkau (1978, pp. 404-405).

The basic generic list was taken from Coffman (1978, pp. 370-376) and amended on the basis of subsequent literature, particularly recent contributions by Oliver, Roback, and Saether. The arrangement of subfamilies (and tribes of the Subfamily Chironominae) follows Saether (1977c). The page numbers listed to the right of the authors indicate where identification keys begin or, if these are not included, where the descriptions begin. Under the "KEYS" columns the stages included are indicated with an "X"; A = adults, P = pupae, L = larvae. When only one species is included in a reference, its name is given in the "COMMENTS" column to help with synonymizing. In references with no keys the stage(s) described are given under "COMMENTS."

Some familiarity with general references for the family will help the reader to arrive at a generic name. At present, adult males and females of most genera can be determined by using the keys in Oliver (1981a) and Saether (1977c) respectively. These two references are cited repeatedly to help the reader determine quickly which genera are not included. Pinder's (1978) key for adult males is also quite useful and contains keys for the British species.

Generic determinations for the immature stages are more difficult. Comprehensive keys are not yet available as formal publications, and determinations are often possible only by using several keys. General taxonomic references for pupae are particularly scarce. Coffman (1978, p. 355) provides a key to tribes, Roback (1957) included pupal keys for many of his taxa, and Pankratova (1977b) contains pupal keys for some Russian species. For the larvae some useful general references include Beck (1976), Bryce and Hobart (1972), Chernovskii (1949), Darby (1962), Hilsenhoff (1981), Mason (1973), Oliver et al. (1978), Pankratova (1977a,b), Roback (1957), and Simpson and Bode (1980).

The process of identifying North American midges will be greatly facilitated by generic keys for adults, pupae, and larvae of Holarctic Chironomidae, currently being prepared by numerous collaborators.

Most specimens encountered during freshwater studies will belong to one of four subfamilies: Tanypodinae, Diamesinae, Orthocladiinae, and Chironominae. The taxonomy of the Tanypodinae is relatively well known for both adults (Roback, 1971) and immatures (Roback, 1974-1981). Kowalyk (1981) used setal patterns on the larval head capsule to distinguish many genera. The Diamesinae lack any integrated references except the generic keys of Oliver (1981a) and Saether (1977c). The Orthocladiinae comprise the largest subfamily and until recently the most definitive references for adults (Brundin, 1956) and immatures (Thienemann, 1944) were in German. Generic keys for the larvae of this large and difficult subfamily are being prepared by Cranston (in press) and Mozley (in preparation). Within the Chironominae the Tribe Tanytarsini is in the greatest disarray. Sublette and Sublette are preparing a much needed revision of Nearctic material. Roback (1957) is still one of the most useful general references for the immature stages. For the Tribe Chironomini Townes (1945) remains extremely useful for identifying adult males to species.

An attempt has been made to include references published up to the end of 1981. Many changes will occur in the near future; revisions for some large and common genera are under way or nearing completion. Although portions of this list may become out-of-date rather quickly, other portions should remain useful for some time. The author welcomes comments concerning this volume's usefulness.

TANYPODINAE

GENUS	REFERENCES	PAGE	KEYS				NUMBER OF SPECIES	COMMENTS
			A♂	A♀	P	L		
Ablabesmyia Johannsen	Roback 1971	356	X				17	also generic key (A) p 233
	Oliver 1981a	433	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Beck & Beck 1966	319	X		X	X	14	larval key has 10 spp
	Roback 1957	28			X	X	4	as *Pentaneura monilis* group
	Simpson & Bode 1980	10				X	2	
	Kowalyk 1981	14				X	-	generic key
	Beck 1976	33				X	12	
Arctopelopia Fittkau	Roback 1971	252	X				3	also generic key (A) p 233
	Oliver 1981a	433	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Roback 1981	85			X		3	larvae of N. Amer. species unknown
	Kowalyk 1981	14				X	-	generic key; inseparable from *Thienemannimyia* & *Conchapelopia*
Brundinia Roback	Roback 1971	86	X				1	*B. eumorpha* as *Psectrotanypus*
	Roback 1978	168			X	X	1	*B. eumorpha*
	Kowalyk 1981	14				X	-	generic key
Cantopelopia Roback	Roback 1971	270	X				1	*C. gesta*; also generic key (A) p 233
	Oliver 1981a	433	X				-	generic key
Clinotanypus Kieffer	Roback 1971	15	X	X			6	
	Oliver 1981a	433	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Boesel 1974	429	X	X	X	X	1	*C. pinguis*
	Roback 1957	46			X	X	2	also generic key (PL) p 27
	Simpson & Bode 1980	10				X	-	generic key
	Kowalyk 1981	14				X	-	generic key
Coelotanypus Kieffer	Roback 1971	28	X	X			9	
	Oliver 1981a	433	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Boesel 1974	429	X	X	X	X	3	
	Roback 1957	47			X	X	2	larval differences of *C. tricolor* & *C. concinnus* desc; generic (PL) key p 27
	Roback 1974	10					3	PL differences in Tables 1-2, p 15
	Kowalyk 1981	14				X	-	generic key
Conchapelopia (Conchapelopia) Fittkau	Roback 1971	244	X					also generic key (A) p 233
	Oliver 1981a	433	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Roback 1981	85			X	X	11	synonymizes *Mesopelopia*
	Kowalyk 1981	14				X	-	generic key; inseparable from *Thienemannimyia* & *Arctopelopia*
Conchapelopia (Helopelopia) Roback	Roback 1971	244	X				2	*C. cornuticaudata* & *C. pilicaudata*
	Roback 1981	85			X	X	1	*C. cornuticaudata*
Conchapelopia (Meropelopia) Roback	Roback 1971	244	X				2	*C. americana* & *C. flavifrons* as *Arctopelopia*
	Roback 1981	85			X	X	2	*C. americana* & *C. flavifrons* + 2 varieties

TANYPODINAE
(continued)

GENUS	REFERENCES	PAGE	KEYS				NUMBER OF SPECIES	COMMENTS
			A♂	A♀	P	L		
Djalmabatista Fittkau	Roback & Tennessen 1978	11					1	*D. pulcher*; PL desc
	Simpson & Bode 1980	10				X	-	generic key
	Kowalyk 1981	14				X	-	generic key
Guttipelopia Fittkau	Roback 1971	257	X				2	also generic key (A) p 233
	Oliver 1981*a*	433	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Oliver et *al.* 1978	3				X	1	*G. guttipennis*
	Roback 1957	30			X		1	*G. guttipennis* (as *Pentaneura*)
	Beck & Beck 1966	332					1	*G. currani*; APL desc
	Kowalyk 1981	14				X	-	generic key
Hudsonimyia Roback	Roback 1979	3	X				1	*H. karelena*; APL desc; gives extra couplet for 1971 key (A)
Krenopelopia Fittkau	Roback 1971	274	X				1	*K. narda*; generic key (A) p 233
	Oliver 1981a	433	X				-	generic key
Labrundinia Fittkau	Roback 1971	276	X				6	also generic key (A) p 233
	Oliver 1981a	433	X				-	generic key
	Beck & Beck 1966	338	X		X	X	5	APL desc
	Oliver *et al.* 1978	3				X	1	unnamed sp
	Simpson & Bode 1980	10				X	1	*L. pilosella*
	Kowalyk 1981	14				X	-	generic key
	Beck 1976	32				X	5	
Larsia Fittkau	Roback 1971	259	X				6	also generic key (A) p 233
	Oliver 1981a	433	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Beck & Beck 1966	349	X	X	X	X	3	APL desc
	Oliver *et al.* 1978	3				X	1	unnamed sp
	Kowalyk 1981	14				X	-	generic key
Macropelopia *(Alotanypus)* Roback	Roback 1971	86	X	X			2	
	Oliver 1981a	433	X				-	generic key; as full genus
	Saether 1977c	33		X			-	generic key.
	Roback 1978	153			X	X	3	*M. venusta* + 2 unnamed spp
Macropelopia *(Apsectrotanypus)* Fittkau	Roback 1971	86	X	X			3	
	Roback 1978	153			X	X	3	*M. johnsoni* + 2 unnamed spp
Macropelopia *(Macropelopia)* Thienemann	Roback 1971	86	X				1	*M. decedens*
	Oliver 1981a	433	X				-	generic key; as full genus
	Saether 1977c	33		X			-	generic key
	Roback 1978	153			X	X	1	*M. decedens*
	Kowalyk 1981	14				X	-	generic key

TANYPODINAE
(continued)

GENUS	REFERENCES	PAGE	KEYS				NUMBER OF SPECIES	COMMENTS
			A♂	A♀	P	L		
Monopelopia Fittkau	Roback 1971	280	X				2	also generic key (A) p 233
	Oliver 1981a	433	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Beck & Beck 1966	335				X	2	APL desc
	Kowalyk 1981	14				X	-	generic key
Natarsia Fittkau	Roback 1971	86	X				2	
	Oliver 1981a	433	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Roback 1978	185			X	X	2	*N. baltimoreus* + 1 unnamed sp
	Oliver *et al.* 1978	3				X	1	*N. baltimoreus*
	Simpson & Bode 1980	10				X	1	*N. baltimoreus*
	Kowalyk 1981	14				X	-	generic key
Nilotanypus Kieffer	Roback 1971	281	X				1	*N. fimbriatus*; generic key (A) p 233
	Oliver 1981a	433	X				-	generic key
	Beck & Beck 1966	345				X	1	*N. americanus (=fimbriatus?)*; APL desc
	Oliver *et al.* 1978	3				X	1	*N. fimbriatus*
	Simpson & Bode 1980	10				X	1	*N. fimbriatus*
	Kowalyk 1981	14				X	-	generic key
Paramerina Fittkau	Roback 1971	271	X				5	also generic key (A) p 233
	Oliver 1981a	433	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Beck & Beck 1966	344					1	*P. anomala*; APL desc
	Oliver *et al.* 1978	3				X	1	*P. fragilis*
	Kowalyk 1981	14				X	-	generic key
Parapelopia Roback	Roback 1971	86	X				1	*P. serta*
	Oliver 1981a	433	X				-	generic key
Pentaneura Philippi	Roback 1971	269	X				2	also generic key (A) p 233
	Oliver 1981a	433	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Beck & Beck 1966	317					1	*P. inconspicua* as *P. inculta*; APL desc
	Simpson & Bode 1980	10				X	1	unnamed sp
	Kowalyk 1981	14				X	-	generic key
Procladius Skuse	Roback 1971	150	X				26	generic key (A) p 233
	Oliver 1981a	433	X				-	generic key
	Saether 1977c	48		X			7	also generic key (A) p 33
	Roback 1980	29			X	X	14	
	Simpson & Bode 1980	10				X	1	*P. sublettei*
	Kowalyk 1981	14				X	-	generic key
Psectrotanypus (Derotanypus) Roback	Roback 1971	86	X				3	
	Oliver 1981a	433	X				-	generic key; as subgenus of *Macropelopia*
	Saether 1977c	33		X			-	generic key; as full genus
	Roback 1978	178			X	X	3	*P. alaskensis* + 2 unnamed spp
	Oliver *et al.* 1978	3				X	1	*P. alaskensis*
Psectrotanypus (Psectrotanypus) Kieffer	Roback 1971	86	X				3	
	Oliver 1981a	433	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Roback 1978	173			X	X	3	1 unnamed sp
	Kowalyk 1981	14				X	-	generic key

TANYPODINAE
(continued)

GENUS	REFERENCES	PAGE	KEYS				NUMBER OF SPECIES	COMMENTS
			A♂	A♀	P	L		
Rheopelopia Fittkau	Roback 1971	237	X				2	*R. acra* & *R. perda*; both as *Thienemannimyia*
	Roback 1981	85			X	X	5	*R. acra*, *R. perda* + 3 unnamed spp
Tanypus Meigen	Roback 1971	54	X	X			11	
	Oliver 1981*a*	433	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Roback 1977	65			X	X	8	
	Roback 1969	411			X	X	7	
	Simpson & Bode 1980	10				X	-	generic key
	Kowalyk 1981	14				X	-	generic key
Telopelopia Roback	Roback 1971	255	X				1	*T. okoboji*; generic key p 233
	Oliver 1981*a*	433	X				-	generic key
	Roback 1981	85			X	X	1	*T. okoboji*
Thienemannimyia Fittkau	Roback 1971	237	X				7	also generic key (A) p 233
	Oliver 1981*a*	433	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Roback 1981	85			X	X	3	*T. fusciceps* (P only), *T. norena* + *T. senata*
	Kowalyk 1981	14				X	-	generic key; inseparable from *Arctopelopia* & *Conchapelopia*
Trissopelopia Kieffer	Roback 1971	267	X				1	*T. ogemawi*; generic key (A) p 233
	Oliver 1981a	433	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Kowalyk 1981	14				X	-	generic key
Xenopelopia Fittkau	Roback 1971	256	X				1	*X. tincta*; generic key (A) p 233
	Oliver 1981a	433	X				-	generic key
	Saether 1977c	33		X			-	generic key
Zavrelimyia Fittkau	Roback 1971	264	X	X			3	also generic key (A) p 233
	Oliver 1981a	433	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Beck & Beck 1966	343					1	*Z. sinuosa* as *Z. carneosa*; APL desc
	Roback 1957	28			X	X	1	*Z. sinuosa* as *Pentaneura carnea*
	Kowalyk 1981	14				X	-	generic key

PODONOMINAE

GENUS	REFERENCES	PAGE	KEYS				NUMBER OF SPECIES	COMMENTS
			A♂	A♀	P	L		
Boreochlus	Wirth & Sublette 1970	337	X	X			3	also generic keys (A) p 336
Edwards	Roback 1957	50			X	X	–	generic keys
	Oliver 1981a	433	X				–	generic key
	Chernovskii 1949	259				X	1	*B. thienemanni*
Lasiodiamesa	Wirth & Sublette 1970	339	X	X			4	also generic keys (A) p 336
Kieffer	Oliver 1981a	433	X				–	generic key
	Roback 1957	50			X	X	–	generic keys
	Saether 1969	8					2	APL desc
	Oliver *et al.* 1978	4				X	1	*L. brusti*
Paraboreochlus	Coffman 1978							lists occurrence in Penna
Thienemann	(Brundin 1966)	308					1	*P. minutissimus*; AP desc
Parochlus	Wirth & Sublette 1970	352	X				1	*P. kiefferi*; generic key (A) p 336
Enderlein	Oliver 1981a	433	X				–	generic key
	Roback 1957				X	X	–	generic keys
Trichotanypus	Wirth & Sublette 1970	342	X	X			5	generic key (A) p 336; 1 pupal desc
Kieffer	Oliver 1981a	433	X				–	generic key
	Oliver *et al.* 1978	4				X	2	*T. posticalis* + 1 unnamed sp
	Tilley 1978	243				X	1	unnamed sp

GENUS	REFERENCES	PAGE	KEYS				NUMBER OF SPECIES	COMMENTS
			A♂	A♀	P	L		
Paraclunio Kieffer	Wirth 1949	175	X	X	X	X	2	generic keys (APL) p 156
	Hashimoto 1976	388	X				-	generic key
	Oliver 1981a	455	X				-	generic key
Telmatogeton Schiner	Wirth 1949	170	X				2	generic keys (APL) p 156
	Hashimoto 1976	388	X				-	generic key
	Oliver 1981a	455	X				-	generic key
Thalassomya Schiner	Wirth 1949	166	X	X	X	X	3	generic keys (APL) p 156
	Hashimoto 1976	388	X				-	generic key
	Wirth 1947	120	X	X			5	
	Wirth 1952	308					1	*T. bureni*; PL desc
	Oliver 1981a	455	X				-	generic key

DIAMESINAE

GENUS	REFERENCES	PAGE	KEYS				NUMBER OF SPECIES	COMMENTS
			A♂	A♀	P	L		
Boreoheptagyia	Oliver 1981a	444	X				-	generic key; list 1 sp - *B. lurida*
Brundin	Saether 1977c	33		X			-	generic key
Diamesa	Hansen & Cook 1976	46	X				30	
Meigen	Oliver 1981a	436	X				-	generic key
	Saether 1977c	33		X			-	generic key
	(Pagast 1947)	464	X				31	also generic key (A) p 445
	" "	515			X		18	also generic key (P) p 505
	Saether 1969	21					3	APL desc
	Saether 1970	78					7	L desc; all unnamed
	Oliver *et al.* 1978	20				X	4	all unnamed
	Tilley 1978	243				X	7	
	Rossaro 1980	306				X	8	
	Chernovskii 1949	170				X	11	
Hesperodiamesa	Sublette 1967a	305					1	*H. sequax*; A desc
Sublette	Oliver 1981a	436	X				-	generic key
	Saether 1977c	33		X			-	generic key
Pagastia	Oliver 1959	49					2	A desc
Oliver	Oliver 1981a	436	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Mason 1973					X	1	as *Pseudodiamesa pertinax*
Potthastia	Oliver 1981a	436	X				-	generic key
Kieffer	Saether 1977c	33		X			-	generic key
	(Pagast 1947)	491	X				5	also generic keys: A p 445, P p 505
	Roback 1957	51			X	X	1	*P. longimanus*
	Oliver *et al.* 1978	20				X	2	*P. longimanus* + 1 unnamed sp
	Simpson & Bode 1980	10				X	1	*P. longimanus*
Protanypus	Saether 1975a	383	X	X	X	X	5	
Kieffer	Oliver 1981a	436	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Roback 1957	51			X	X	1	*P. morio*
Pseudodiamesa	Oliver 1959	54	X	X			4	
Goetghebuer	Oliver 1981a	436	X				-	generic key
	Saether 1977c	33		X			-	generic key
	(Pagast 1947)	445	X		X		-	generic keys: A p 445, P p 505
	Saether 1970	78					1	*P. pertinax*; L desc
	Roback 1957	51				X	-	generic key; as *Syndiamesa*
Pseudokiefferiella	Saether 1977c	74		X			-	generic key
Zavřel	Tilley 1978					X	1	unnamed sp

DIAMESINAE
(continued)

GENUS	REFERENCES	PAGE	KEYS				NUMBER OF SPECIES	COMMENTS
			A♂	A♀	P	L		
Sympotthastia Pagast	Oliver 1981a	436	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Saether 1969	34					1	unnamed sp; P desc
	(Pagast 1947)	445	X				-	generic key
	" "	505			X		-	generic key

PRODIAMESINAE

GENUS	REFERENCES	PAGE	KEYS				NUMBER OF SPECIES	COMMENTS
			A♂	A♀	P	L		
Compteromesa Saether	Saether 1981b	194					1	*C. oconeensis*; A desc; erects genus
Monodiamesa Kieffer	Saether 1973b	675	X		X	X	5	
	Oliver 1981a	436	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Saether 1967	200				X	4	
	Oliver *et al.* 1978	20				X	1	*M. bathyphila*
Odontomesa Pagast	Oliver 1981a	436	X				-	generic key
	Saether 1977c	33		X			-	generic key
	(Pagast 1947)	445	X				-	generic key
	" "	505			X		-	generic key
	Roback 1957	51			X	X	1	*O. fulva*
Prodiamesa Kieffer	Oliver 1981a	436	X				-	generic key
	Saether 1977c	33		X			-	generic key
	(Pagast 1947)	497	X				3	also generic key (A) p 445
	" "	505			X		-	generic key
	Roback 1957	51			X	X	4	
	Chernovskii 1949	176				X	4	

ORTHOCLADIINAE

GENUS	REFERENCES	PAGE	KEYS				NUMBER OF SPECIES	COMMENTS
			A♂	A♀	P	L		
Abiskomyia	Oliver 1981a	444	X				-	generic key
Edwards	Saether 1977c	87		X			-	generic key
	Saether 1976	33	X			X	-	generic keys
	(Thienemann 1944)	553			X		2	*A. paravirgo, A. virgo*
	" "	607				X	1	*A. paravirgo*
Acricotopus	(Hirvenoja 1973)	81	X		X	X	1	*A. lucens*
Kieffer	Oliver 1981a	444	X				-	generic key
	Saether 1977c	87		X			-	generic key
Baeoctenus	Saether 1976	33	X	X			1	*B. bicolor*
Saether	Oliver 1981a	444	X				-	generic key
	Saether 1977c	87		X			-	generic key
	Saether 1977b	2358					1	*B. bicolor*; PL desc
Brillia	Sublette 1967b	494	X				5	
Kieffer	Oliver 1981a	444	X				-	generic key
	Saether 1977c	87		X			-	generic key
	Roback 1957	63			X	X	5	
	Saether 1969						1	*B. retifinis*; APL desc
Bryophaenocladius	Sublette 1970	75	X				3	
Thienemann	Oliver 1981a	444	X				-	generic key
	Saether 1977c	87		X			-	generic key
	Saether 1976	33	X	X			-	generic keys
	Saether 1973a	51					4	A desc
	Roback 1957	75			X	X	1	*B. furcatus* (as *Hydrobaenus*)
	(Thienemann 1944)	553			X		5	European spp
	" "	613				X	5	European spp; generic key (L) p 607
Camptocladius	Oliver 1981a	444	X				-	generic key
van der Wulp	Saether 1977c	87		X			-	generic key
	Roback 1957	95				X	1	*C. stercorarius* (as *Smittia*)
	(Thienemann 1944)				X		1	*C. stercorarius*
Cardiocladius	Sublette 1967b	487	X				3	presents diagnoses in tabular form
Kieffer	Oliver 1981a	444	X				-	generic key
	Saether 1977c	87		X			-	generic key
	Roback 1957	34			X	X	1	*C. obscurus?*
Chaetocladius	Oliver 1981a	444	X				-	generic key
Kieffer	Saether 1977c	87		X			-	generic key
	Saether 1976	33	X	X			-	generic keys
	Saether 1969	93					1	*C. oliveri*; A desc
	(Thienemann 1944)	553			X		13	European spp; as *Dyscamptocladius*
	" "	607				X	10	European spp; as *Dyscamptocladius*
Chasmatonotus	Oliver 1981a	444	X				-	generic key
Loew	Saether 1977c	87		X			-	generic key

ORTHOCLADIINAE
(continued)

GENUS	REFERENCES	PAGE	KEYS				NUMBER OF SPECIES	COMMENTS
			A♂	A♀	P	L		
Clinocladius Sublette	Oliver 1981a	444	X				-	generic key; lists 1 sp: *C. subparallelus*
	Sublette 1970	50					1	*C. subparallelus*; A desc
Clunio Haliday	Stone 1947	219	X				14	PL desc for *C. vagans*
	Wirth 1949	158	X		X	X	1	*C. marshalli*; also generic keys (APL)
	Oliver 1981a	444	X				-	generic key
	Saether 1977c	87		X			-	generic key
	Hashimoto 1976	388	X				-	generic key
	Michailova 1980	9					3	European
Corynoneura Winnertz	Sublette 1967a	326	X	X			4	diagnoses in tabular form
	Boesel & Winner 1980	506	X	X			4	
	Oliver 1981a	444	X				-	generic key
	Saether 1977c	87		X			-	generic key
	Roback 1957	60			X	X	3	
	Oliver et *al.* 1978	13				X	5	all unnamed spp
Cricotopus *(Cricotopus)* van der Wulp	(Hirvenoja 1973)	136	X	X	X	X	35	European fauna
	Oliver 1981a	444	X				-	generic key; no subgenera
	Saether 1977c	87		X			-	generic key
	LeSage & Harrison 1980	60	X	X	X	X	10	
	Roback 1957	68			X	X	10	subgenera not distinguished
	Oliver 1977	98					3	*bicinctus*-group; APL desc
	Oliver *et al.* 1978	13				X	5	
	Simpson & Bode 1980	11				X	3	
Cricotopus *(Isocladius)* Kieffer	(Hirvenoja 1973)	254	X	X	X	X	22	European fauna
	LeSage & Harrison 1980	60	X	X	X	X	1	*C. sylvestris*
	Oliver et *al.* 1978	13				X	2	*C. laricomalis*-group & *C. sylvestris*-group
	Simpson & Bode 1980	11				X	2	*C. intersectus*-group & *C. sylvestris*-group
	Roback 1957	68			X	X	6	subgenera not distinguished
Cricotopus *(Nostococladius)* Ashe & Murray	Ashe & Murray 1980	105					1	erect subgenus; *C. lygropis* - PL desc
	(Hirvenoja 1973)	136	X	X			1	*C. lygropis* as subgenus *Cricotopus*
	Wirth 1957	122					1	*C. nostocicola*; APL desc
	Roback 1957	68			X	X	2	*C. nostocicola*, *C. furcatus*; subgenus not distinguished
Diplocladius Kieffer	Oliver 1981a	444	X				-	generic key
	Saether 1977c	87		X			-	generic key
	Roback 1957	56			X	X	-	generic keys
	Oliver et *al.* 1978	13				X	1	*D. cultriger*
Doncricotopus Saether	Saether 1981a	223					1	*D. bicaudatus*; APL desc
Epoicocladius Zavřel	Oliver 1981a	444	X				-	generic key
	Saether 1977c	87		X			-	generic key
	Roback 1957	95			X	X	1	*E. ephemerae* (as *Smittia*)
	Oliver *et al.* 1978	13				X	1	*E. flavens*

ORTHOCLADIINAE
(continued)

GENUS	REFERENCES	PAGE	KEYS				NUMBER OF SPECIES	COMMENTS
			A♂	A♀	P	L		
Eretmoptera Kellogg	Wirth 1949	159	X				2	also generic key (A) p 156
	Oliver 1981a	388	X				-	generic key
	Saether 1977c	87		X			-	generic key
	Hashimoto 1976	388	X				-	generic key
Eukiefferiella Thienemann	(Lehmann 1972)	353	X		X		20	European spp
	Saether & Halvorsen 1981	280					-	generic diagnoses (APL); redefine genus
	Oliver 1981a	444	X				-	generic key
	Oliver *et al.* 1978	13				X	7	4 spp unnamed
	Simpson & Bode 1980	11				X	3	3 species groups
	(Zavřel 1939)	3			X	X	20	European spp
	Chernovskii 1949	189				X	12	Russian spp; couplets 106-128
Eurycnemus van der Wulp	Oliver 1981a	444	X				-	generic key
	Saether 1977c	87		X			-	generic key
	Oliver *et al.* 1978	13				X	1	unnamed sp
	Murray & Ashe 1981	357					1	*E. crassipes*; PL desc
Euryhapsis Oliver	Oliver 1981b	711	X				3	also generic diagnoses (APL); *E. cilium* - PL desc
Freemaniella Saether	Saether 1976	33	X	X			-	generic keys
Georthocladius Strenzke	(Strenzke 1950)	233						
	Coffman 1978	373					-	lists occurrence in N. Amer.
Gymnometriocnemus Goetghebuer	Oliver 1981a	444	X				-	generic key
	Saether 1977c	87		X			-	generic key
	Saether 1969	127					2	A desc
	(Thienemann 1944)	553			X		2	European spp
	" "	607				X	5	European spp; *G. subnudus*, *G. terrestris* + 3 unnamed spp
Habrobaenus Saether	Saether 1977b	2354					1	*H. hudsoni*; AP desc
	Saether 1980b	115					1	*H. hudsoni*; A (female) desc
Halocladius (Halocladius) Hirvenoja	(Hirvenoja 1973)	114	X	X	X	X	5	European spp
	Oliver 1981a	444	X				-	generic key; no subgenera
	Saether 1977c	87		X			-	generic key; no subgenera

ORTHOCLADIINAE
(continued)

GENUS	REFERENCES	PAGE	KEYS				NUMBER OF SPECIES	COMMENTS
			A♂	A♀	P	L		
Halocladius (Psammocladius) Hirvenoja	(Hirvenoja 1973)	109	X	X	X	X	1	*H. braunsi*; European
Heleniella Gowin	Oliver 1981a	444	X				-	generic key
	Saether 1977c	87		X			-	generic key
	Saether 1969	130					2	AP desc
	(Thienemann 1944)	553			X		1	*H. thienemanni*
	" "	607				X	1	*H. thienemanni*
Heterotanytarsus Spärck	Saether 1975b	268	X		X		4	1 larval desc, *H. perennis*
	Oliver 1981a	444	X				-	generic key
	Saether 1977c	87		X			-	generic key
	Roback 1957	65			X	X	1	*H. apicalis* (as *Metriocnemus*)
Heterotrissocladius Spärck	Saether 1975c	5	X	X	X	X	12	also 5 unnamed spp ("A-E")
	Oliver 1981a	444	X				-	generic key
	Saether 1977c	87		X			-	generic key
	Oliver *et al.* 1978	13				X	1	*H. changi*
Hydrobaenus Fries	Saether 1976	70	X	X	X	X	19	
	Oliver 1981a	444	X				-	generic key
	Saether 1977c	87		X			-	generic key
	Oliver et *al.* 1978	13				X	1	unnamed sp
Krenosmittia Thienemann	Oliver 1981a	444	X				-	generic key
	Saether 1977c	87		X			-	generic key
	(Wülker 1957)	420	X		X		2	*K. camptophleps*, *K. hispanica*
	Saether 1969	142					1	*K.* cf. *boreoalpina*; PL desc
	Oliver *et al.* 1978	13				X	1	unnamed sp
Lapposmittia Thienemann	(Brundin 1956)	56	X				-	generic key
	Saether 1977c	87		X			-	generic key
	(Thienemann 1944)	553			X		1	*L. parvibarba*
Limnophyes Eaton	Saether 1975d	1030	X				20	
	Oliver 1981a	444	X				-	generic key
	Saether 1977c	87		X			-	generic key
	Cranston 1979	19					1	*L. globifer*; APL desc
	Chernovskii 1949	214				X	6	Russian spp
Maricladius Sublette	Oliver 1981a	444	X				-	generic key; lists 1 sp - *M. subaterrimus*
	Sublette 1970	84					1	*M. subaterrimus*; A (male) desc

ORTHOCLADIINAE
(continued)

GENUS	REFERENCES	PAGE	KEYS				NUMBER OF SPECIES	COMMENTS
			A♂	A♀	P	L		
Mesocricotopus Brundin	(Brundin 1956)	52	X				1	*M. thienemanni*; generic key (A)
	Saether 1977c	87		X			-	generic key
	Saether 1976	37			X		-	generic key
Metriocnemus van der Wulp	Oliver 1981a	444	X				-	generic key
	Saether 1977c	87		X			-	generic key
	Roback 1957	65			X	X	11	larval couplets 5-13, except *M. clavaticornis*
	(Thienemann 1944)	553			X		23	European spp
	" "	607				X	14	European spp
Nanocladius *(Nanocladius)* Kieffer	Saether 1977a	6	X	X	X	X	12	synonymizes *Microcricotopus*
	Oliver 1981a	444	X				-	generic key
	Saether 1977c	87		X			-	generic key; includes subgenera
	Simpson & Bode 1980	11				X	5	
Nanocladius *(Plecopteracoluthus)* Steffan	Saether 1977a	6	X	X	X	X	2	
	Oliver 1981a	444	X				-	generic key; as full genus
	Saether 1977c	87		X			-	generic key; includes subgenera
Oliveridia Saether	Saether 1976	33	X	X	X	X	1	generic keys (APL); *O. tricornis*; as *Oliveria*
	Oliver 1981a	444	X				-	generic key
	Saether 1977c	87		X			-	generic key; as *Oliveria*
	Saether 1980d	399					-	changes generic name to *Oliveridia*
Oreadomyia Kevan & Cutten-Ali-Khan	Oliver 1981a	444	X				-	generic key; lists 1 sp - *O. albertae*
Orthocladius *(Eudactylocladius)* Thienemann	Soponis 1977	15	X	X	X	X	-	subgeneric keys
	Oliver 1981a	444	X				-	generic key, no subgenera
	Saether 1977c	87		X			-	generic key, includes subgenera
	Roback 1957				X	X	1	*O. dubitatus*; as *Hydrobaenus*
Orthocladius *(Euorthocladius)* Thienemann	Soponis 1977	15	X	X	X	X	-	subgeneric keys
	Saether 1977c	87		X			-	generic key, includes subgenera
	Oliver *et al.* 1978	13				X	2	unnamed spp
Orthocladius *(Orthocladius)* van der Wulp	Soponis 1977	20	X	X	X	X	28	also subgeneric keys (APL) p 15
	Saether 1977c	87		X			-	generic key, includes subgenera

ORTHOCLADIINAE
(continued)

GENUS	REFERENCES	PAGE	KEYS				NUMBER OF SPECIES	COMMENTS
			A♂	A♀	P	L		
Orthocladius *(Pogonocladius)* Brundin	Soponis 1977	15	X	X	X	X	-	subgeneric keys
	Saether 1977c	87		X			-	generic key, includes subgenera
	Oliver *et al.* 1978	13				X	1	unnamed sp
Paracladius Hirvenoja	(Hirvenoja 1973)	93	X	X	X	X	3	European spp
	Oliver 1981a	444	X				-	generic key
	Saether 1977c	87		X			-	generic key
Paracricotopus Thienemann & Harnisch	Saether 1980c	129					2	*P. niger* & *P. glaber*; APL desc
	Oliver 1981a	444	X				-	generic key
	Saether 1977c	87		X			-	generic key
	(Thienemann 1944)	553			X		-	generic key; lists 3 spp
	" "	607				X	1	*P. niger* var *muscicola*
Parakiefferiella Thienemann	Oliver 1981a	444	X				-	generic key
	Saether 1977c	87		X			-	generic key
	(Wülker 1957)	411					6	APL desc; European spp
	Roback 1957	92			X	X	1	*P. coronata*, as *Eukiefferiella*
	Oliver *et al.* 1978	13				X	1	unnamed sp
	(Thienemann 1944)	553			X		3	European spp
	" "	607				X	2	European spp
Paralimnophyes Brundin	Saether 1976	33	X	X			-	generic keys
	Saether 1977c	87		X			-	generic key
Parametriocnemus Goetghebuer	Oliver 1981a	444	X				-	generic key
	Saether 1977c	87		X			-	generic key
	Saether 1969	108					4	APL desc
	Roback 1957	65			X	X	1	*P. lundbecki*, as *Metriocnemus*
	Oliver *et al.* 1978	13				X	1	*P. graminicola*
Paraphaenocladius Thienemann	Oliver 1981a	444	X				-	generic key
	Saether 1977c	87		X			-	generic key
	Saether 1969	123					1	*P. nasthecus*; AP desc
	(Thienemann 1944)	553			X		2	*P. impensus*, *P. irritus*
	" "	607				X	1	*P. impensus*
	Oliver *et al.* 1978	13				X	2	unnamed spp
Paratrichocladius Santos Abreu	(Hirvenoja 1973)	88	X	X	X		2	European spp
	Oliver 1981a	444	X				-	generic key
	Saether 1977c	87		X			-	generic key
	Saether 1969	77					1	*P. fontinalis*, as *Syncricotopus*; A desc
	Rossaro 1979	75					1	*P. rufiventris*; L desc
Paratrissocladius Zavřel	Saether 1976	253	X				2	=*Parachaetocladius*; generic keys (APL) p 33
	Oliver 1981a	444	X				-	generic key, as *Parachaetocladius*
	Saether 1977c	87		X			-	generic key

ORTHOCLADIINAE
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GENUS	REFERENCES	PAGE	KEYS				NUMBER OF SPECIES	COMMENTS
			A♂	A♀	P	L		
Parorthocladius Thienemann	(Brundin 1956)	52	X				-	generic key
	Saether 1977c	87		X			-	generic key
	Roback 1957	95			X	X	1	*P. nudipennis*, as *Smittia*
	(Thienemann 1944)	553			X		5	European spp
	" "	607				X	-	generic key; 4 spp listed but not distinguished
Phycoidella Saether	Oliver 1981a	444	X				-	generic key
	Saether 1971a	1810					1	*P. dentolatens*; APL desc
	Saether 1977c	33		X			-	generic key
Platycladius Sublette	Oliver 1981a	444	X				-	generic key; lists 1 sp - *P. pleuralis*
	Sublette 1970						1	*P. pleuralis*; A (male) desc
Psectrocladius Kieffer	Sublette 1967b	531	X				7	
	Oliver 1981a	444	X				-	generic key
	Saether 1977c	87		X			-	generic key
	(Wülker 1956)	5	X		X		14	European spp
	Oliver *et al.* 1978	13				X	5	*P. simulans* + 4 unnamed spp
	Roback 1957	86			X	X	10	some spp are *Nanocladius*; 4 unnamed spp
	Chernovskii 1949	180				X	6	
Pseudorthocladius Goetghebuer	Oliver 1981a	444	X				-	generic key
	Saether 1977c	87		X			-	generic key
	Saether 1969	126					1	*P. dumicaudus*; A desc
	(Thienemann 1944)	553			X		1	*P. curtistylus*
	" "	607				X	1	*P. curtistylus*
	Soponis 1980	485					1	*P. macrostomus*; A desc
Pseudosmittia Goetghebuer	(Brundin 1956)	169	X				8	also generic key (A) p 52
	Oliver 1981a	444	X				-	generic key
	Saether 1977c	87		X			-	generic key
	(Thienemann 1944)	553			X		1	*P. simplex*
	" "	607				X	5	European spp
	Saether 1969	144					1	*P. setavena*; A desc
Psilometriocnemus Saether	Oliver 1981a	444	X				-	generic key
	Saether 1969	105					1	*P. triannulatus*; AP desc
Rheocricotopus Thienemann & Harnisch	(Lehmann 1969)	364	X		X		10	keys in German & English
	Oliver 1981a	444	X				-	generic key
	Saether 1977c	87		X			-	generic key
	Saether 1969	85					3	APL desc
	Oliver *et al.* 1978	13				X	2	unnamed spp
Smittia Holmgren	Oliver 1981a	444	X				-	generic key
	Saether 1977c	87		X			-	generic key
	Roback 1957	94			X	X	1	*S. atterima*; all other spp in key now belong to other genera

ORTHOCLADIINAE
(continued)

GENUS	REFERENCES	PAGE	KEYS				NUMBER OF SPECIES	COMMENTS
			A♂	A♀	P	L		
Symbiocladius	Oliver 1981a	444	X				-	generic key
Kieffer	Saether 1977c	87		X			-	generic key
	Roback 1957	56			X	X	-	generic keys
	Oliver *et al.* 1978	13				X	1	*S. equitans*
Synorthocladius	Oliver 1981a	444	X				-	generic key
Thienemann	Saether 1977c	87		X			-	generic key
	Roback 1957	75			X	X	1	*S. semivirens*, as *Hydrobaenus*
	Simpson & Bode 1980	11				X	1	*S.* nr. *semivirens*
	Oliver *et al.* 1978	13				X	1	unnamed sp
Tethymyia	Wirth 1949	160	X		X	X	1	*T. aptena*; generic keys (APL) p 150
Wirth	Oliver 1981a	444	X				-	generic key
	Saether 1977c	87		X			-	generic key
	Hashimoto 1976	388	X				-	generic key
Thalassosmittia	Sublette 1967a	318					4	A desc, as *Saunderia*
Strenzke & Remmert	Oliver 1981a	444	X				-	generic key
	Saether 1977c	87		X			-	generic key; synonymizes *Saunderia*
	Roback 1957	95			X	X	3	*T. marina*, *T. pacifica* & *T. clavicornis*; all as *Smittia*
Thienemannia	(Brundin 1956)	52	X				-	generic key
Kieffer	Saether 1977c	87		X			-	generic key
	Roback 1957	65				X	1	*T. clavaticornis*, as *Metriocnemus*
Thienemanniella	Sublette 1970	89	X	X			4	
Kieffer	Boesel & Winner 1980	506	X	X			2	
	Oliver 1981a	444	X				-	generic key
	Saether 1977c	87		X			-	generic key
	Roback 1957	60			X	X	2	
	Oliver *et al.* 1978	13				X	3	all unnamed spp
	Simpson & Bode 1980	11				X	2	
Tokunagaia	Saether 1973a	56					2	erects genus; synonymizes *Adactylocladius*
Saether	Saether 1977c	87		X			-	generic key
	Saether 1969	53					4	APL desc, as *Adactylocladius*
Trissocladius	Saether 1976	165	X				2	also generic keys (AP) p 33
Kieffer	Saether 1977c	87		X			-	generic key
	Saether 1980a	467					1	*T. brevipalpis*; AL desc
Tvetenia	Saether & Halvorsen 1981	270					-	generic diagnoses (APL); synonymize *Eukiefferiella discoloripes* group
Kieffer	(Lehmann 1972)	353	X		X		5	*verralli*-group & *E. saanensis*, as *Eukiefferiella*
	(Zavřel 1939)	3			X	X	8	as *Eukiefferiella discoloripes*-type
	Simpson & Bode 1980	11				X	2	*bavarica*-group & *discoloripes*-group, as *Eukiefferiella*
	Chernovskii 1949	189				X	5	couplets 99-105, as *Eukiefferiella*

ORTHOCLADIINAE
(continued)

GENUS	REFERENCES	PAGE	KEYS				NUMBER OF SPECIES	COMMENTS
			A♂	A♀	P	L		
Zalutschia Lipina	Saether 1976	186	X	X	X	X	13	also generic keys (APL) p 33
	Oliver 1981a	444	X				-	generic key
	Saether 1977c	87		X			-	generic key
	Oliver *et al.* 1978	13				X	1	unnamed sp
	Soponis 1979	125					1	*Z. briani*; APL desc

CHIRONOMINAE

TANYTARSINI

GENUS	REFERENCES	PAGE	KEYS				NUMBER OF SPECIES	COMMENTS
			A♂	A♀	P	L		
Cladotanytarsus Kieffer	Oliver 1981a	437	X				-	generic key
	Pinder 1978	142	X				4	British spp; also generic key (A) p 100
	Saether 1977c	140		X			-	generic key
	Roback 1957	129			X	X	5	as *Atanytarsus*; also generic keys (PL) p 125
	Oliver *et al.* 1978	11				X	3	all unnamed spp
Constempellina Brundin	Saether 1977c	140		X			-	generic key
	Roback 1957	127			X	X	1	*C. brevicosta*; as *Zavrelia*
	(Brundin 1948)	6			X	X	1	*C. brevicosta*
	Oliver *et al.* 1978	11				X	2	unnamed spp
	(Brundin 1947)	84	X				-	generic key
Corynocera Zetterstedt	Oliver 1981a	437	X				-	generic key
	Saether 1977c	140		X			-	generic key
	(Lehmann 1973)	398					2	*C. ambigua, C oliveri*; APL desc
	Oliver *et al.* 1978	11					1	unnamed sp
Lauterbornia Kieffer	Oliver 1981a	437	X				-	generic key
	Townes 1945	71	X				2	as *Tanytarsus (Tanytarsus) coracinus* gr
Lenziella Kieffer	Oliver 1981a	437	X				-	generic key
	Saether 1977c	140		X			-	generic key
	Saether 1971a	1817					1	*L. cruscula*; APL desc
Micropsectra Kieffer	Oliver 1981a	437	X				-	generic key
	Pinder 1978	142	X				10	British spp; also generic key (A) p 100
	Saether 1977c	140		X			-	generic key
	Säwedal 1976	110	X		X		9	*notescens*-group; Palearctic spp
	Säwedal 1979	136	X				1	*M. brundini*; addendum to 1976 key
	Roback 1957	135			X	X	6	as *Calopsectra*, group *Micropsectra*
	Oliver *et al.* 1978	11				X	2	unnamed spp
	Säwedal & Willassen 1980	56					1	*M. borealis;* AP desc
	Säwedal 1981	27					1	*M. tori;* APL desc
Neozavrelia Goetghebuer	(Fittkau 1954)	166	X	X			4	European spp
	Saether 1977c	140		X			-	generic key
Paratanytarsus Bause	Oliver 1981a	437	X				-	generic key
	Pinder 1978	146	X				9	British spp; also generic key (A) p 100
	Reiss & Säwedal 1981	84	X		X		20	Palearctic spp; pupal key p 89, 16 spp
	Saether 1977c	140		X			-	generic key
	Roback 1957	128			X	X	8	as *Calopsectra*, group *Paratanytarsus*; generic keys (PL) p 125
	Oliver *et al.* 1978	11				X	2	unnamed spp
	Säwedal & Langton 1977	167					1	*P. tenellulus;* AP desc

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TANYTARSINI
(continued)

GENUS	REFERENCES	PAGE	KEYS				NUMBER OF SPECIES	COMMENTS
			A♂	A♀	P	L		
Rheotanytarsus	Oliver 1981a	437	X				-	generic key
Bause	(Lehmann 1971)	352	X				8	European spp; keys in German & English
	Pinder 1978	148	X				6	British spp
	Saether 1977c	140		X			-	generic key
	Roback 1957	125			X	X	-	generic keys
	Simpson & Bode 1980	15				X	2	species groups
Stempellina	Oliver 1981a	437	X				-	generic key
Bause	Pinder 1978	150	X				1	*S. bausei;* also generic key (A) p 100
	Saether 1977c	140		X			-	generic key
	(Brundin 1948)	6			X	X	5	European spp
	Roback 1957	127			X	X	2	
	Oliver et *al.* 1978	11				X	3	all unnamed spp
	Webb 1969	99	X				3	also 1 P desc - *S. ranota*
Stempellinella	Pinder 1978	150	X				3	British spp; also generic key (A) p 100
Brundin	Saether 1977c	140		X			-	generic key
	(Brundin 1948)	6			X	X	2	European spp
	Oliver et *al.* 1978	11				X	1	unnamed spp
Tanytarsus	Oliver 1981	437	X				-	generic key
van der Wulp	(Reiss & Fittkau 1971)	89	X				53	European spp; keys in German & English
	Pinder 1978	150	X				28	British spp; also generic key (A) p 100
	Saether 1977c	140		X			-	generic key
	Roback 1957	131			X	X	11	as *Calopsectra*, group *Calopsectra*; generic keys (PL) p 125
	Oliver et *al.* 1978	11				X	3	all unnamed spp
	Simpson & Bode 1980	15				X	3	*T. coffmani* + 2 species groups
	Roback 1975	71					1	*T. coffmani*; APL desc
Thienemanniola	Saether 1977c	140		X			-	generic key
Kieffer	(Lehmann 1973)	381					1	*T. ploenensis*; APL desc
Zavrelia	Oliver 1981a	437	X				-	generic key
Kieffer	Pinder 1978	158	X				1	*Z. pentatoma*
	Saether 1977c	140		X			-	generic key
	(Brundin 1948)	6			X	X	1	*Z. pentatoma*
	Roback 1957	127				X	1	*Z. pentatoma*

CHIRONOMINAE

PSEUDOCHIRONOMINI

GENUS	REFERENCES	PAGE	KEYS				NUMBER OF SPECIES	COMMENTS
			A♂	A♀	P	L		
Pseudochironomus Malloch	Saether 1977a	60	X		X	X	9	
	Oliver 1981a	437	X				-	generic key
	Saether 1977c	33		X			-	generic key; erects tribe

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GENUS	REFERENCES	PAGE	KEYS				NUMBER OF SPECIES	COMMENTS
			A♂	A♀	P	L		
Acalcarella Shilova	Saether 1977a	89	X		X	X	-	generic keys
	Saether 1977c	33		X			-	generic key
	Oliver *et al.* 1978	5				X	1	unnamed *sp*
Beckidia Saether	Saether 1977a	120	X			X	3	as *Beckiella*; generic keys (APL) p 89
	Saether 1979	315					-	synonymizes *Beckiella*
Chernovskiia Saether	Saether 1977a	108	X	X	X	X	2	also generic keys (APL) p 89
	Saether 1977c	33		X			-	generic key
Chironomus Meigen	Townes 1945	116	X				22	as *Tendipes*; also generic key (A) p 12
	Lindeberg & Wiederholm 1979	105	X				25+	European spp
	Oliver 1981a	437	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Roback 1957	109			X	X	6	as *Tendipes (Tendipes)*
	(Geiger *et al.* 1978)	102				X	18	European spp
	Beck & Beck 1969a	3	X			X	4	
	Wülker *et al.* 1971	6					3	*C. staegeri, C. crassicaudatus, C. frommeri*; APL desc
	Sublette & Sublette 1974	1					2	*C. maturus, C. whitseli*; APL desc
Cladopelma Kieffer	Saether 1977a	89	X		X	X	-	generic keys
	Oliver 1981a	437	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Oliver *et al.* 1978	5				X	1	unnamed *sp*
Cryptochironomus Kieffer	Sublette 1964	129					10	A (+ some PL) desc
	Saether 1977a	89	X		X	X	-	generic keys
	Oliver 1981a	437	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Townes 1945	97	X				6	
	Curry 1958	431			X	X	4	
	Chernovskii 1949	99				X	17	
Cryptotendipes Lenz	Saether 1977a	97	X				10	also generic keys (APL) p 89
	Oliver 1981a	437	X				-	generic key
	Saether 1977c	171		X			3	also generic key p 33
	Beck & Beck 1969b	294					1	*C. casuarius*; APL desc
	Oliver *et al.* 1978	5				X	2	unnamed spp
Cyphomella Saether	Saether 1977a	101	X				6	also generic keys (APL) p 89; some PL desc
	Saether 1977c	33		X			-	generic key

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CHIRONOMINI
(continued)

GENUS	REFERENCES	PAGE	KEYS				NUMBER OF SPECIES	COMMENTS
			A♂	A♀	P	L		
Demicryptochironomus Lenz	Saether 1977a	133	X				6	also generic keys (APL) p 89
	Oliver 1981a	437	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Townes 1945	155	X				2	as *Harnischia (Harnischia)*
Dicrotendipes Kieffer	Townes 1945	102	X				10	as *Tendipes (Limnochironomus)*; generic key (A) p 12
	Oliver 1981a	437	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Roback 1957	109			X	X	4	as *Tendipes (Limnochironomus)*
	Webb 1972	76			X	X	6	
	Beck 1976	55				X	6	
Einfeldia Kieffer	Townes 1945	111	X				4	as *Tendipes (Einfeldia)*
	Oliver 1981a	437	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Roback 1957	109			X	X	1	*E. insolita* as *Tendipes*
	Oliver 1971	1591					1	*E. synchrona*; APL desc
	Oliver *et al.* 1978	5				X	3	*E. synchrona* + 2 unnamed spp
Endochironomus Kieffer	Townes 1945	64	X				2	as *Tanytarsus (Endochironomus)*; generic key p 12
	Oliver 1981a	437	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Roback 1957	119			X	X	2	as *Tanytarsus (Endochironomus)*
	Simpson & Bode 1980	13				X	2	
Gillotia Kieffer	Saether 1977a	133	X				2	also generic keys (APL) p 89
Glyptotendipes Kieffer	Townes 1945	136	X				13	3 subgenera; generic key (A) p 12
	Oliver 1981a	437	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Beck & Beck 1969a	3	X			X	2	
	Roback 1957	123			X	X	5	
	Simpson & Bode 1980	13				X	1	*G. lobiferus*
	Sublette & Sublette 1973	1					1	*G. barbipes*; APL desc
Goeldichironomus Fittkau	Fittkau 1965	209					1	*G. holoprasinus*; APL desc
	Oliver 1981a	437	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Beck & Beck 1969a	3	X			X	1	*G. holoprasinus*
Graceus Goetghebuer	Oliver 1981a	437	X				-	generic key
	Pinder 1978	100	X				1	*G. ambiguus*
	Saether 1977c	33		X			-	generic key
Harnischia Kieffer	Saether 1977a	89	X		X	X	-	generic keys
	Townes 1945	147	X				10	
	Beck & Beck 1969b	296					5	APL desc
	Oliver 1981a	437	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Oliver *et al.* 1978	5				X	1	*H. curtilamellata*
	Simpson & Bode 1980	13				X	1	*H. curtilamellata*

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CHIRONOMINI

(continued)

GENUS	REFERENCES	PAGE	KEYS				NUMBER OF SPECIES	COMMENTS
			A♂	A♀	P	L		
Kiefferulus Goetghebuer	Townes 1945	102	X				1	*K. dux;* as *Tendipes (Kiefferulus)*
	Oliver 1981a	437	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Roback 1957	109			X	X	1	*K. tendipediformis;* as *Tendipes*
	Beck & Beck 1970	38					1	*K. dux;* PL desc
Lauterborniella Bause	Townes 1945	20	X				3	also generic key (A) p 12
	Oliver 1981a	437	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Roback 1957	107				X	3	also generic keys (PL) p 96
	Oliver *et al.* 1978	5				X	1	*L. agrayloides*
Microchironomus Kieffer	Saether 1977a	89	X		X	X	-	generic keys
	Oliver 1981a	437	X				-	generic key
	Saether 1977c	33		X			-	generic key
Microtendipes Kieffer	Townes 1945	23	X				3	+ 3 varieties of *M. pedellus;* also generic key (A) p 12
	Oliver 1981a	437	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Roback 1957	108			X	X	3	also generic keys (PL) p 96
Nilodorum Kieffer	Saether 1977c	33		X			-	generic key
	Beck & Beck 1970	35					1	*N. devineyae;* PL desc
	Beck 1976	44				X	1	*N. devineyae*
Nilothauma Kieffer	Townes 1945	34	X				3	as *Kribioxenus;* generic key (A) p 12
	Oliver 1981a	437	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Roback 1957	96			X	X	1	*N. brayi;* as *Kribioxenus*
	Simpson & Bode 1980	13				X	1	*N. babiyi*
Omisus Townes	Townes 1945	27	X				1	*O. pica;* generic key (A) p 12
	Oliver 1981a	437	X				-	generic key
	Saether 1980b	118					1	*O. pica;* A (female) desc
	Beck & Beck 1970	29					1	*O. pica;* PL desc
	Beck 1976	44				X	1	*O. pica*
Pagastiella Brundin	Oliver 1981a	437	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Oliver *et al.* 1978	5				X	1	*P. ostansa*
	Webb 1969	102					1	*P. ostansa*, as *Paralauterborniella;* APL desc
Parachironomus Lenz	Saether 1977a	89	X		X	X	-	generic keys
	Beck & Beck 1969b	284	X			X	8	
	(Lehmann 1970)	132	X				16	European spp; keys in German & English
	Oliver 1981a	437	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Beck 1976	53				X	8	
	Simpson & Bode 1980	13				X	2	

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CHIRONOMINI
(continued)

GENUS	REFERENCES	PAGE	KEYS				NUMBER OF SPECIES	COMMENTS
			A♂	A♀	P	L		
Paracladopelma Harnisch	Jackson 1977	1326	X		X	X	13	
	Saether 1977a	89	X		X	X	-	generic keys
	Oliver 1981a	437	X				-	generic key
	Saether 1977c	33		X			-	generic key
Paralauterborniella Lenz	Townes 1945	32	X				3	as *Apedilum*
	Oliver 1981a	437	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Roback 1957	96			X	X	1	*P. nigrohalteralis*
	Beck & Beck 1970	31					2	PL desc
	Oliver *et al.* 1978	5				X	1	*P. nigrohalteralis*
Paratendipes Kieffer	Townes 1945	27	X				6	also generic key (A) p 12
	Oliver 1981a	437	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Roback 1957	96			X	X	-	generic key
	Ward & Cummins 1978	272					1	*P. albimanus*; L desc
	Simpson & Bode 1980	13				X	1	*P. albimanus*
	Chernovskii 1949	128				X	4	
Pedionomus Sublette	Oliver 1981a	437	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Beck 1976	44				X	1	*P. beckae*
	Sublette 1964	137					1	*P. beckae*; APL desc
Phaenopsectra Kieffer	Townes 1945	71	X				6	as *Tanytarsus (Tanytarsus)*
	Oliver 1981a	437	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Roback 1957	119			X	X	4	as *Tanytarsus (Tanytarsus)*; generic keys (PL) p 96
	Simpson & Bode 1980	13				X	2	
	Oliver *et al.* 1978	5				X	2	unnamed spp
Polypedilum *(Pentapedilum)* Kieffer	Townes 1945	61	X				3	also generic key (A) p 12
	Oliver 1981a	437	X				-	generic key; no subgenera
	Saether 1977c	33		X			-	generic key; includes subgenera
	Roback 1957	114			X	X	2	also generic keys (PL) p 96
Polypedilum *(Polypedilum)* Kieffer	Maschwitz 1976	45	X		X	X	20	
	Townes 1945	47	X				20	also generic key (A) p 12
	Saether 1977c	33		X			-	generic key; includes subgenera
	Roback 1957	114			X	X	5	also generic keys (PL) p 96
	Simpson & Bode 1980	13				X	2	
	Oliver *et al.* 1978	5				X	4	
Polypedilum *(Tripodura)* Townes	Townes 1945	37	X				15	also generic key (A) p 12
	Saether 1977c	33		X			-	generic key
	Roback 1957	114			X	X	3	also generic keys (PL) p 96
	Oliver *et al.* 1978	5				X	1	unnamed sp
	Simpson & Bode 1980	13				X	1	*P.* nr. *scalaenum*
Robackia Saether	Saether 1977a	123	X		X	X	3	also generic keys (APL) p 89
	Oliver *et al.* 1978	5				X	1	*R. demeijerei*

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CHIRONOMINI
(continued)

GENUS	REFERENCES	PAGE	KEYS				NUMBER OF SPECIES	COMMENTS
			A♂	A♀	P	L		
Saetheria Jackson	Jackson 1977	1326	X		X	X	3	1 unnamed sp
	Townes 1945	147	X				1	*S. tylus*; as *Harnischia (Cladopelma)*
Stenochironomus Kieffer	Townes 1945	85	X				10	also generic key (A) p 12
	Oliver 1981a	437	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Roback 1957	96			X	X	-	generic keys (PL)
	Beck & Beck 1970	33					3	PL desc
Stictochironomus Kieffer	Townes 1945	78	X				10	as *Tanytarsus (Stictochironomus)*; generic key (A) p 12
	Oliver 1981a	437	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Roback 1957	119			X	X	3	as *Tanytarsus (Stictochironomus)*; 2 unnamed spp
	Roback 1966	169					1	*S. annulicrus*; PL desc
Tribelos Townes	Townes 1945	66	X				5	as *Tanytarsus (Tribelos)*
	Oliver 1981a	437	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Roback 1957	119			X	X	2	as *Tanytarsus (Tribelos)*; generic key (PL) p 96
	Simpson & Bode 1980	13				X	1	*T. jucundus*
	Beck 1976	51				X	3	
Wirthiella Sublette	Sublette 1960	216					1	*W. modocensis*; A desc
Xenochironomus Kieffer	Townes 1945	92	X				5	also generic key (A) p 12
	Oliver 1981a	437	X				-	generic key
	Saether 1977c	33		X			-	generic key
	Roback 1963	235			X	X	5	
	Roback 1957	96			X	X	-	generic keys

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Biosystematic Study of the Spiranthes cernua Complex

Charles J. Sheviak
Curator of Botany
New York State Museum

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Spiranthes is the most perplexing orchid genus in our flora. It is the least understood and the one that furnishes to authors who grow impatient under the restraints imposed by cautious progress, the best opportunities for the multiplication of species. It is a genus that repays intensive observation in the field and prolonged contemplation in the herbarium.

Oakes Ames, 1921

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INTRODUCTION

The genus *Spiranthes* has gained considerable notoriety as a taxonomically perplexing group. The history of its study includes alternating periods of splitting and lumping, and a general lack of acceptance of any one treatment has been apparent. In large part this situation seems to reflect the northeastern viewpoint from which much of this work was done. Some of the most confusing species are wide-ranging; treatments which appeared appropriate in a limited geographic context often were inadequate and misleading elsewhere. This has been particularly true of the *S. cernua* complex, a group harboring some of the most intractable problems in the genus. The present study has benefited from an initial focus on the largely neglected western portions of the complex, where a combination of unique character states and striking habitat differences provided some early insight; subsequent work in the East has been guided by the Midwestern findings and has shown the complex to behave similarly in both areas, and, ultimately, has revealed its intrinsic nature.

In 1870, E. L. Greene, in his paper on the vegetation of central Illinois, reported from the prairies of the region "a *Spiranthes* of doubtful species." He was thus the first worker to recognize the systematic intricacies of the *Spiranthes cernua* complex in the prairies. It was not until very recently, however, that anyone seriously began to study the problem. Over one hundred years elapsed between Greene's publication and the description of *S. magnicamporum*, the first Midwestern member of the complex to be separated from *S. cernua*.

This lack of treatment of the group stems in part from the difficulty encountered in the use of herbarium material. *Spiranthes* does not provide many characters of suitable quality for systematic work, and many that are present in living material, including some of the most important, are lost when preserved as dried specimens. The situation was made more difficult by the poor representation of midwestern material in the major eastern herbaria. The pioneering work that was conducted in the East thus suffered from a paucity of quality midwestern specimens; the material that was available was often collected on early expeditions or by early settlers and was very poorly preserved. Under these conditions, eastern workers failed to recognize the distinct nature of much of the variation in the Midwest and attempted for a century to accommodate these western plants within an eastern framework. The result of this situation is a major disparity of treatment of the same plants by different regional floras, due to their authors' inability to similarly treat western populations within an eastern system that did not in fact recognize their existence.

It was under such conditions that I began a study of the complex in the Midwest. In 1968, I began to attempt to determine specimens of *Spiranthes cernua* from the region, both in the herbarium and the field. It eventually became evident that two of the taxa reported by various workers did not occur there, although it was clear that the populations referred to *S. cernua* were not uniform to any reasonable degree, and that taxonomically distinct entities were present. It was also clear that some were not members of any currently recognized taxa, and in 1973 I described the new species, *S. magnicamporum*.

The recognition of a new species in the complex was significant beyond the addition of another taxon, for the emphasis during this century had been on a reduction of taxa from specific rank to varietal status under *S. cernua*. The publication of *S. magnicamporum* was thus contrary to established precedent. Significantly, it was in part the lack of understanding of the situation in the Midwest that had led eastern workers to abandon specific status for some of the eastern taxa; Midwestern specimens were viewed as serving to obscure the distinctions between eastern species. This situation suggested that a reassessment of the entire complex was in order.

Another important factor contributing to the confusion in the group has been the lack of information on the reproductive biology of the plants. Although polyembryony has long been known in some members of the complex and its correlation with agamospermy established, the presence or absence of apomixis, although frequently cited in the literature, has not been utilized nearly to its potential for elucidation of the evolution and relationships of the various members of the complex and of the intrinsic nature of the complex as a whole. This failure on the part of earlier workers no doubt arose through the almost complete lack of cytological study, although the evidence for polyploidy in the genus should have stimulated this line of investigation. The present study has shown the significance of cytological study to an understanding of the reproductive biology of the complex and allowed assessment of morphological variation from an evolutionary standpoint.

This paper is intended to introduce the problem, to summarize the principal findings of the study, and to present the resulting taxonomic treatment. More detailed analyses of the nature and origins of the variation patterns and the evolution and biogeography of the complex will appear in subsequent papers.

For convenience, reference is made throughout this work to *S. cernua*, *S. odorata*, *S. ochroleuca*, and *S. magnicamporum* as distinct at the specific level. Great variation is recognized in *S. cernua*, whereas the other species are delimited more strictly. These interpretations are based on the findings of this study presented below and in subsequent papers.

These four species were chosen for study because of their morphological similarity, overlapping ranges, and apparent interrelationship. Variation in the complex is primarily between these species. Additionally, *S. romanzoffiana* appears to be involved in the Great Lakes region and eastward, but its vast subarctic and cordilleran distribution prohibited its study. The nearly allopatric distributions of *S. romanzoffiana* and the *S. cernua* complex furthermore suggests only local interaction between them. *Spiranthes romanzoffiana* is thus only dealt with peripherally. Closely related to *S. romanzoffiana* is *S. porrifolia*, a far-western species which is geographically isolated and morphologically distinct; it does not appear to be involved in the complex.

Three additional species must be mentioned. *Spiranthes ovalis* is structurally very similar to *S. cernua* and may be closely related; *S. casei* is similar to *S. ochroleuca* in certain floral and foliar characters, which similarly may reflect a relationship. Both *S. ovalis* and *S. casei*, however, are entirely distinct from members of the complex, and any involvement in it is apparently of a different order than that of the other species mentioned here. These two species are consequently not treated in this work. The last species of interest here is *S. parksii*. This morphologically unusual plant is linked to the complex by its reproductive mode and some morphological characters, and indeed it is likely related. Its extremely narrow range and certain peculiar morphological features suggest, however, that it is a product of the complex rather than a contributor to the variability in the group; since essential live material was not available, the species was not included in this study.

The species discussed here, with the exception of *S. casei* and *S. parksii*, are characterized by dense inflorescences in which the flowers often appear in three or four ranks. The only other North American member of the genus to share this characteristic is the spring-blooming and apparently not closely related *S. lucida;* all other species characteristically exhibit more open inflorescences with the flowers spiraled about the rachis or secund. Hence, the species considered here form a natural group which provides meaningful limits to the study.

TAXONOMIC REVIEW

Spiranthes L. C. Richard, antedated by *Gyrostachys* Persoon, *Ibidium* Salisbury, and others, has been designated a *nomen conservandum.* The genus has been variously delimited, and in the broadest sense over three hundred species may be included within it. Schlechter (1920) proposed the recognition of a number of comparatively smaller genera. If his approach is adopted, *Spiranthes* is seen to contain only a few dozen species, with a center of diversity in eastern North America. Few species occur in the Old World, although the actual count may vary depending on how one interprets the extraordinarily wide ranging *S. sinensis.* Schlechter's treatment has resulted in a proliferation of small, often poorly differentiated genera which has led a number of workers to return to a broad concept of *Spiranthes.* With regard to the present work, taxonomic decisions at the generic level are of no direct importance, for the nomenclature of the taxa considered in this work does not vary as different generic concepts are adopted. For philosophical and rhetorical convenience, *Spiranthes* is here used in the strictest sense.

The focus of this study is a species complex centering on *S. cernua* (L.) L. C. Rich. This species is based on the Linnaean *Ophrys cernua* (1753), described from "Virginia, Canada." This northeastern plant was concisely described as bearing a few thick, fibrous roots and long, basal, linear leaves. Flowers were nodding, with an oblong, acute, lip. Later, Torrey (1826) proposed *S. cernua* var. *latifolia*, now recognized as a synonym of *S. lucida* (Eaton) Ames, and not part of the *S. cernua* complex. Similarly, Chapman (1897) described *S. cernua* var. *parviflora*, a synonym of *S. ovalis* Lindl. and not part of the *S. cernua* complex. Eaton (1829) included in his treatment of *Neottia cernua* a brief description of var. *major.* The plant was described as tall, with a somewhat leafy stem and very large flowers. Although mentioned by Ames (1905b), it has not been otherwise treated.

Other taxa referable to the *S. cernua* complex have been described intermittently since *Species Plantarum.* Walter (1788) described *Limodorum autumnale* from the Southeast. It was described as bearing large flowers, the stem bracted and pubescent, leafy, and with the spike doubly spiralled. Ames (1905b) and later workers have treated this taxon as synonymous with *S. cernua.* Rafinesque (1833) next described *S. petiolaris* from Illinois. This was reported as bearing long-petiolate, cuneate, lanceolate basal leaves and lanceolate-acuminate leaves on the base of the stem. The spike was densely spiralled, with large, curved, white flowers. The lip was described as "*obl. acut.*" This taxon has not been treated elsewhere.

Nuttall (1834) described, as *Neottia odorata*, a plant from swampy sites in North Carolina. Without mention of earlier taxa, he described this species, "the largest and finest *Spiranthes* in the United States," as exhibiting a leafy stem with long basal leaves. The white to greenish, fragrant flowers were recurved; the lip was ovate. The "root runs considerably," according to Nuttall. Beginning early in this century, the proper rank of this plant has been a subject of controversy. Small (1913) placed it in synonymy under *S. cernua*. Ames (1921) stated, "It would seem that *S. odorata* owes its success in escaping synonymy to the fact that it was born under authority and subsequently sustained because efforts to recognize it have persisted. I am convinced that *S. odorata* is conspecific with *S. cernua*." Correll (1940) published the combination *S. cernua* var. *odorata*. These treatments have not been universally accepted, however. Fernald (1950) maintained the specific status of *S. odorata*, a position recently adopted by Luer (1975) and popular with southern workers familiar with the plant. This debate has generated some confusion, for Gleason (1952) treated *S. cernua* var. *odorata* as distinct from *S. odorata*, an impossible situation since both names refer to the same plant.

Two additional taxa of interest here are *Gyrostachys constricta* and *G. triloba*, described by Small (1898). The first, from marshes in Louisiana, was described as a tall, stout plant with linear to linear-spatulate leaves mainly on the lower portion of the stem. The flowers, born in a dense spike, possessed lips deltoid-ovate in outline, truncate at the base and constricted above the middle. The second, from southern Florida, was described as bearing oblong to elliptic-oblong leaves mainly near the base of the stem. The lip was three-lobed, with a cordate base. Small considered *G. constricta* to be related to *G. vernalis*, but Ames (1905b) reported that the specimens with which Small compared *G. constricta* were in actuality *S. odorata*, and he reduced Small's taxon to synonymy under this earlier species. Small (1913) later treated *G. constricta* as a synonym of *Ibidium cernuum*, along with *G. odorata*. Small (1898) originally reported *G. triloba* as without close relatives and later (Small, 1913) maintained it (as *Ibidium trilobum*) as distinct. Ames (1905b), however, had treated it as synonymous with *S. odorata*, stating that lips of the type were not three-lobed as described by Small, but rather more characteristic of *S. odorata*. More recently, Correll (1950) was noncommital and referred all synonyms to *S. cernua* while maintaining *S. cernua* var. *odorata*. Luer (1972, 1975), however, placed *G. constricta* under *S. cernua* but followed Ames in the treatment of *G. triloba*.

In Britton's *Manual* (Britton, 1901), Rydberg described *G. ochroleuca*. This plant bore linear, petiolate basal leaves and similar, but often sessile, leaves on the base of the stem. The spike was dense, with ochroleucous to greenish yellow, strongly fragrant flowers. The lower floral bracts were noted as longer than the flowers. The description ended, "type from Mt. Washington, Mass." No other taxon in the *S. cernua* complex has caused so much confusion. Ames (1905b) early reduced *G. ochroleuca* to varietal status under *S. cernua*. Later (Ames, 1921), he commented on the near impossibility of separating the two taxa and stated that the only reliable difference known to him was the presence of polyembryonic seeds in *S. cernua* and of monoembryonic seeds in var. *ochroleuca*. Correll (1950) did not treat this taxon separately, but rather merely mentioned it as impractical to separate in his treatment of var. *odorata*. Recently, however, Luer (1975) recognized *S. ochroleuca* as distinct at the specific level.

Questions regarding the proper rank of this taxon, however, have not been responsible for the confusion surrounding it. Rather, the identity of the plant has been of primary importance. Different workers have variously limited the species' range to the East Coast or expanded it to include the entire range of *S. cernua*. Sheviak (1973) explained this disparity of treatments largely on the basis of confusion with other members of the *S. cernua* complex. Most recently, Sheviak and Catling (1980) have established the identity of *S. ochroleuca* and shown it to be distinct at the specific level.

Another taxon in the complex is *Ibidium incurvum*, described in 1906 by Jennings from an island in Lake Erie. This plant was very thoroughly described. It possessed linear-oblong to ovate, petiolate basal leaves and linear-oblanceolate leaves on the lower portion of the stem. The dense inflorescence supported white to rarely somewhat yellowish flowers recurved on the spike. The lip was more or less contracted at the middle with a truncate or cordate-orbicular base. The feature which Jennings used to separate this plant from others in the complex was the elongated, incurved nature of the basal callosities of the lip, a situation indicated by Jennings to be atypical of *I. cernuum.* He further suggested that the closest relative of *I. incurvum* was *I. odoratum*, but stated that "the differences are . . . quite marked between the species." Later (Jennings, 1953), however, he commented on the occurrence of long, incurved callosities in both typical *S. cernua* and var. *ochroleuca* and indicated that *I. incurvum* consequently could not be recognized. This taxon has been overlooked in the past, and until recently only Britton and Brown (1913) and Winter (1936) had treated it. Sheviak and Catling (1980) have shown it to be synonymous with *S. cernua*.

The last taxon proposed in the *S. cernua* complex to date is *S. magnicamporum* (Sheviak, 1973), a prairie species described from Illinois. This species was described as possessing tuberously thickened roots and lacking leaves at anthesis. The strongly fragrant white to ivory flowers, born in a dense inflorescence, were rather narrowly ringent with spreading or ascending lateral sepals and an ovate to oblong lip. It was suggested that this species was most closely related to *S. odorata*, from which it differed in the nature of the roots, the lack of cauline leaves, and the loss of leaves before anthesis. Similarly, it differed in these features from *S. cernua*, from which it also was distinct in floral configuration and lip shape.

Most significantly, it was found (Sheviak, 1973) that much of the confusion surrounding both *S. odorata* and *S. ochroleuca* stemmed from attempts to accommodate *S. magnicamporum* within these taxa. Rootless specimens of *S. magnicamporum* were found annotated *S. cernua* var. *odorata* by Correll, whereas ones bearing roots were determined as *S. cernua* by him. Catling and Cruise (1974) report a similar confusion of *S. odorata* and *S. casei* by Correll. Reports of *S. ochroleuca* from the Midwest were also found to be largely based on *S. magnicamporum*. Correll's confusion regarding the identity of *S. odorata* suggested that his concept of the taxon was faulty, and hence his conclusions regarding the proper status of the plant were subject to doubt. A need for a critical reevaluation of *S. odorata* was thus evident (Sheviak, 1973).

The specific status of *S. magnicamporum* was originally determined largely on ecological grounds (Sheviak, 1973). Although *S. magnicamporum* was very distinct from *S. cernua* in well developed, live material, it was early apparent that under stressed conditions individuals of the two species often became very similar, and it was only through cultivation that their potential phenotypes became evident. Furthermore, many characters that served to distinguish the two species were lost with preservation, so that determination of herbarium specimens was sometimes exceedingly difficult. Consequently, it was only through the study of cultivated material and extensive field experience that determination of the specific status of *S. magnicamporum* was possible. This was based on the parapatric distributions of the two species which resulted from their different habitat requirements. Furthermore, the few stations that could be found at which the species occurred together disclosed very little evidence of hybridization.

It was apparent, however, that hybridization was not impossible, although experimental crosses produced no seed. Because of the difficulties encountered with herbarium work, I was very reluctant to accept as evidence for hybridization solely intermediate herbarium specimens. If a hybrid origin of such a plant was reasonable in light of locality and ecology, then more weight was given to its intermediate condition. In this fashion, I hypothesized a remote hybrid origin for what I termed (Sheviak, 1973, 1974b) the "low prairie race." The hypothetical ancestry of this race and limited familiarity with it dictated that it not be treated definitively, and it consequently was treated merely as a vague, ill-defined race of possibly hybrid origin.

A major factor preventing the definitive treatment of the low prairie race was the occurrence of occasional specimens from the prairie region which were variously intermediate between *S. cernua* and *S. magnicamporum* and yet quite distinct from the low prairie race. During the initial phase of this study only a few such specimens were known to me, and they served more to obscure the identity of the low prairie race than to cast doubt on the distinctness of *S. magnicamporum*. Subsequent work has shown these intermediates to be widespread and important members of the complex in much of the prairie region and even in portions of the forested regions to the east. This diverse assemblage of variably intermediate forms has been the focus of much of this study and is referred to below as the "prairie complex."

A salient feature of the prairie complex is a series of teratologies which occur in varying degrees and combinations over much of the area occupied by the complex. Significantly, similar conditions occur in northeastern populations supporting specimens intermediate between *S. cernua* and *S. ochroleuca*.

Clearly, then, the publication of *S. magnicamporum* was merely a first step toward an understanding of the *S. cernua* complex, even in the prairies, and work continued on it, focusing on the natures of "intermediate" specimens and certain monstrous individuals. Eventually it became possible to characterize the various taxa in the complex and to identify a number of morphological types that did not appear referable to any presently known taxa but were often to some extent intermediate between *S. cernua* and other species. The salient features of the variation pattern in the complex are presented graphically in Figure 12.

SYNOPSIS OF CHARACTERS

Spiranthes are difficult taxonomic subjects. Size of individual plants varies greatly depending on the vigor of the plant and its habitat; individual organs also show considerable variation, and floral characters are often more unstable than vegetative ones. Root systems, frequently of some use as sources of characters, are only occasionally collected. Leaf characters are useful in a few cases, but often leaves are lacking at anthesis or are not collected. Inflorescences are all spicate, although variation in the presentation of the flowers occurs. The flowers themselves are discouragingly uniform, with the majority of species exhibiting an essentially identical size range; except for the pink-flowered *S. sinensis* of Eurasia, color is characteristically white, frequently with various shadings of yellow and green. Seeds can be very important but frequently are not present in herbarium material. This situation is made even more difficult by the loss of some characters with preservation, and the alteration of qualitative ones from one condition to another.

It is thus not surprising that the genus has gained a reputation of being exceedingly difficult systematically, and virtually all of the principal works dealing with the eastern North American species have been prefaced with comments regarding the complexities of the group and the poor state of our knowledge of it (Ames, 1903, 1904, 1906, 1921, 1947; Correll, 1940, 1950; Fernald, 1946a, 1946b; Case, 1964; Luer, 1972, 1975; Sheviak, 1973; Catling and Cruise, 1974; Sheviak and Catling, 1980). Characters utilized in the past and others investigated during the present study are reviewed below.

Roots

Spiranthes odorata, *S. ochroleuca*, and *S. cernua* are characterized by slender, usually wide-spreading roots. In contrast, *S. magnicamporum* bears roots that are tuberously thickened and abruptly descending; the roots of *S. romanzoffiana* are also commonly tuberous, often bulbously so. Virtually the entire prairie complex exhibits tuberous roots; in some forms they are extraordinarily thickened. Since the last two species are the only likely contributors of root tuberosity in the complex, this character can be an aid in assessing the origins of variation in *S. cernua*.

Spiranthes odorata is characterized by stoloniferous roots, and this characteristic has been used by various authors to aid in distinguishing this taxon from *S. cernua* and *S. magnicamporum* (Correll, 1950; Sheviak, 1973; Luer, 1975). Correll (1950) and Catling (1980), however, indicated the occasional occurrence of the stoloniferous condition in *S. cernua*, and this behavior has been observed in some cultivated material of this species during the present study. Root apices have produced shoots when pot-grown plants were maintained at summer temperatures for several weeks following blooming; the delay in the onset of normal autumn and winter tempertures seems to promote stoloniferous reproduction in *S. cernua*.

Leaves

Spiranthes cernua and *S. magnicamporum* bear leaves typical of most of the genus, varying from linear-lanceolate to oblanceolate, and exhibiting distinct petioles. Leaves of *S. odorata* are broader, elliptical to oblong-oblanceolate, and petiolar development is often reduced or lacking. In *S. ochroleuca*, the linear-oblanceolate to narrowly elliptical leaves commonly lack petioles. The leaves of *S. cernua* and *S. magnicamporum* are thin and submembranaceous, whereas both *S. odorata* and *S. ochroleuca* produce fleshier leaves. Those of *S. odorata* have been described as succulent (Correll 1940, 1950), but are actually aerenchymatous, a condition probably reflecting the swampy habitat of the species. The leaves of well-grown specimens of *S. ochroleuca* are slightly fleshy and highly flexible, which, together with a vaguely rough surface, contribute a sensation to touch very similar to that of crepe rubber. In depauperate or etiolated specimens, however, leaves are merely subcoriaceous or membranaceous. The distinctive leaf characters are obscure in depauperate or stressed specimens of all taxa.

Leaves of *S. magnicamporum* are wholly basal and ascending. Those of *S. cernua* are similar, but in some plants one or two leaves may be born on the very base of the stem. The similarly basal to subbasal leaves of *S. ochroleuca* curve generally throughout the length of the blade, and a lack or abbreviation of petioles and relative abundance of leaves in this species produce a compact rosette at the base of the plant. These leaves are strongly canaliculate, contributing to the distinct vegetative appearance of the plant. In *S. odorata* the leaves are not wholly basal but may extend partially up the stem, often merging gradually with the bracts below the inflorescence.

Leaf persistence, the presence or absence of leaves at anthesis, frequently is a useful character and has been utilized rather widely (Ames, 1905b; Fernald, 1946a; Correll, 1950; Case, 1964; Luer, 1972, 1975; Sheviak, 1973). Within the *S. cernua* complex, *S. magnicamporum* and members of the prairie complex are distinct in the fugaceous nature of their leaves. Plants with a truly fugaceous habit lose their leaves sometime before the inflorescence appears above ground. In S. *magnicamporum*, frequently three or more weeks elapse between the loss of leaves and the appearance of the spike. In S. *ochroleuca*, S. *odorata*, and typical S. *cernua*, leaves persist during and after flowering if conditions are favorable. Under comparatively xeric conditions, however, leaves may be lost before blooming, although even then this usually occurs as the inflorescence develops rather than before. Conversely, at the northern limit of its range in North Dakota, S. *magnicamporum* blooms much earlier than elsewhere, sometimes in mid-August, and then occasionally retains its leaves into anthesis. This situation is the result of the shorter growing season and the independent control of leaf loss and flowering.

Cultivation is very useful in determining the inherent natures of the plants in question. With adequate moisture and freedom from competition, S. *magnicamporum* and the fugaceous prairie plants continue to lose their leaves well in advance of anthesis, whereas specimens of the rest of the S. *cernua* complex maintain their leaves in good condition.

Inflorescence

The spiral arrangement of flowers in the inflorescence has long been recognized as the most striking morphological feature of the genus and has contributed two of the names proposed for it, *Gyrostachys* and *Spiranthes*. The degree to which the coil of flowers is spiralled around the rachis varies greatly from secund to so densely coiled that the spiral aspect is lost. Ames, in his pioneering works on the North American species, utilized this character extensively. It has become standard practice to introduce keys to the species with a couplet separating "single-ranked" from "multi-ranked" species. The single-ranked plants are those with obvious coils laxly extended along the rachis, or, in extreme cases, with a secund arrangement of flowers. The multiranked plants produce a dense inflorescence in which usually three or four rather variably coiled ranks ascend the rachis. These plants frequently produce inflorescences with no obvious ranking at all, thus complicating the situation.

The emphasis placed on this character in keys has caused considerable confusion in determination of some plants, especially in the S. *cernua* complex. This problem has arisen not so much through difficulties intrinsic to the character itself as to a lack of understanding of the nature of the "multiranked" inflorescence. In reality, the inflorescence types divided into two categories in the past represent the extremes of a continuous range of variation. This is easily demonstrated in terms of phyllotaxy. In "single-ranked" plants, the parastichy is clearly recognizable as the coil of flowers around the rachis. The higher the angle of the parastichy, the lower the phyllotaxy, until the secund condition is reached, at which time phyllotaxy jumps to 1/1 (it is philosophically more satisfactory to consider this state as 1/∞). Hence, as the angle of the parastichy decreases, the phyllotaxy increases until, between 1/5 and 1/4, the superposed flowers are brought into such vertical proximity that orthostichies become evident, and the "multiranked" condition is reached. "Multiranked" plants thus exhibit a phyllotaxy of 1/4 or 1/3. The orthostichies may be either vertical or themselves exhibit varying degrees of spiralling; in some cases this becomes great enough that ranking of any sort is not evident.

Since the *Spiranthes cernua* complex can be characterized as comprised of those plants with multiranked inflorescences of rather large flowers, some further comments on the behavior of the inflorescence in multiranked species are necessary. The division of single-ranked and multiranked configurations at the 1/5–1/4 boundary is not due merely to the ease with which the eye perceives geometric configurations. In multiranked plants, the number of flowers per cycle is not usually a product of the angle of the parastichy as it is in single ranked types. Hence, the presence of three or four orthostichies is not necessarily affected by the "openness" nor "laxness" of the spike. This is an important point, for only very rarely do even the most densely coiled spikes of single-ranked species exceed a phyllotaxy of 1/5; indeed, I have seen this situation only twice, in S. *grayi*. Thus specimens and races of the S. *cernua* complex with high angled parastichies are readily separable from similar single-ranked species. For example, some specimens of S. *cernua* are occasionally determined as S. *vernalis*, because they exhibit a high-angled parastichy and hence are run through the single-ranked portions of standard keys (Sheviak, 1974a, 1974b); the phyllotaxy of such plants, however, shows them to be S. *cernua*.

Phyllotaxies lower than 1/4 do occasionally occur in normally multiranked taxa, however, and complicate the situation. Ames (1921) indicated that much of the variability of S. *cernua* was due to changes in the vigor of the plants. He traced the development of large specimens from seed and pointed out that the aspect of the inflorescence varied more or less continuously from year to year "until the limit of vigor of the vegetative system is attained." My horticultural experience with these plants confirms this. Particularly small plants, probably almost always very young ones, may occasionally produce truly single-ranked inflorescences with phyllotaxies lower than 1/4. These inflorescences are small and few-flowered; they are occasional in *S. cernua* and somewhat more common in *S. ochroleuca*.

Changes in vigor are not solely responsible for single-ranked specimens, however. In the Northeast, two races of *S. cernua* are characterized by truly single-ranked inflorescences. These plants can confound determination by the uninitiated.

Floral Bracts

The original description of *Gyrostachys ochroleuca* (Rydberg, 1901) attributed unusually long bracts to this species, the lower exceeding the flowers in length, a condition supposedly not occurring in *S. cernua*. This character was initially adopted by Ames (1905b), but later abandoned (Ames, 1921). The bracts of *S. ochroleuca* do tend to be longer than those of *S. cernua*, but the relationship is not constant (Sheviak and Catling, 1980). The longest floral bracts occur in robust specimens of *S. magnicamporum* and in some members of the prairie complex.

Flowers

A number of floral characters are of significance in the genus, but their use is often difficult or ambiguous due to phenotypic plasticity and modifications introduced during preservation. Recent statistically-based work (Simpson and Catling, 1978; Sheviak and Catling, 1980; Catling, 1980, 1981), however, has demonstrated their reliability and utility in the great majority of specimens.

Floral shape varies significantly in the complex but is difficult to assess consistently and has been little used. It has been mentioned by Ames (1905b), Fernald (1946a), Correll (1950), Luer (1972, 1975), Sheviak (1973), Catling and Cruise (1974), and Sheviak and Catling (1980), often rather in passing.

Spiranthes cernua, *S. ochroleuca*, and many *S. odorata* bear flowers with a general dorsi-ventral curvature. The lip matches the curve of the rest of the flower for about one-half to two-thirds of its length and then rather abruptly diverges downward apically. In contrast, *S. magnicamporum* possesses narrowly ringent flowers (Sheviak, 1973). Curvature is restricted to the base, and the lip curves rather generally throughout its length, although the apex may be abruptly reflexed. Similar, but usually less slender flowers commonly occur also in *S. odorata*. In this species, either generally curved or ringent flowers may be produced by individual plants in different years.

The position of the lateral sepals varies significantly between species. The hooded nature of flowers of *S. romanzoffiana* is one of the two characteristics typically used to separate this species from *S. cernua*. Except for this one case, few workers have used lateral sepal orientation as a taxonomic character (Ames, 1921; Sheviak, 1973; Catling and Cruise, 1974; Luer, 1975).

In the *S. cernua* complex, lateral sepal orientation is significant. In *S. cernua*, the lateral sepals occupy the same plane as the rest of the flower; they spread very slightly at the base, parallel the flower for most of their lengths, and then abruptly curve inward apically. For the most part, *S. ochroleuca* and *S. odorata* duplicate this pattern, although in the former, the sepals are frequently appressed to the petals, and the latter frequently approaches the behavior of *S. magnicamporum*. In the last species, the sepals spread more or less widely from the base of the flowers, often also ascending above the rest of the flower.

In preserved material, it is often possible to assess the lateral shape of the flower, but sepal position is only rarely determinable, and the ease with which it may be altered during pressing dictates that it be used with extreme caution. Even in the field, where these characters are of considerable use, caution is needed due to the frequently great phenotypic plasticity exhibited by individual plants. As I learned early in this study (Sheviak, 1973), depauperate and stunted individuals of different taxa may appear essentially identical in floral configuration but diverge greatly in phenotype when provided with conditions more favorable for growth, then exhibiting the characteristics typical of their taxa.

The labellum, or lip, is of considerable interest to taxonomists working in the Orchidaceae, for it very frequently exhibits species-specific variation of great usefulness in determination. It is due probably more to the established precedent in the family, however, than to any value intrinsic in the character itself that lip features have been so emphasized in *Spiranthes*. In his original description of *Ophrys cernua*, Linnaeus (1753) described the lip as "*labio inferiore oblongo, acuto, integro.*" Since that time, lip shape has been one of the principal characters stressed by workers in the genus. Yet, early in this century Ames (1905b), in a discussion of the difficulties encountered in the group, wrote, "Another circumstance which leads to confusion is the interpretation, often faulty, of the lip characters in species which exhibit little or no consistency in the outline or measurements of this important organ." His later emphasis on lip configuration is thus remarkable. Lip variation is minor and often nearly as great within species as between them. Lip shape may be altered during pressing. It is also particularly susceptible to modification by the environment and endogenous physiological fluctuations. Hence, the frequently smaller flowers at the apex of a spike usually possess lips very different from those of the large basal flowers. In robust specimens of some taxa, it is often possible to find lips characteristic of three species along a single inflorescence. Consequently, some recent work (Catling, 1980) has emphasized comparisons of flowers on the basal portion of the spikes. Difficulty in application of this character led to the reduction to varietal status of *S. odorata* by Correll (1940) and, apparently, of *S. ochroleuca* by Ames (1905b).

Three of the species in the complex, *S. odorata*, *S. magnicamporum*, and *S. ochroleuca*, possess very similar lips. They vary from rhombic-ovate or ovate in *S. odorata* to ovate or oblong in *S. magnicamporum* and *S. ochroleuca*. The margins are nearly to quite entire. In contrast, the distinctly lacerate lip of *S. cernua* is characterized by a distinct orbicular or suborbicular dilated base, the lip then appearing somewhat constricted at the center. This distinction has been recognized in varying degrees in the past (Ames, 1921; Correll, 1950; Luer, 1972, 1975; Sheviak, 1973). Except for the lack of a secondary apical dilation, the lip of *S. cernua* suggests the pandurate form seen in *S. romanzoffiana* and can be viewed as intermediate between this species and the three other members of the *S. cernua* complex. Lip shape of *S. cernua* is highly variable, and some of the variation can be used in conjunction with other characters to deduce gene flow in the complex.

Lip texture is of considerable significance in the genus but has been little used (Ames, 1904; Sheviak, 1973; Luer, 1975; Sheviak and Catling, 1980). *Spiranthes odorata*, *S. ochroleuca*, and *S. magnicamporum* are characterized in the herbarium by lips that are thick and rather fleshy, especially centrally, and which are rather opaque to transmitted light. In contrast, typical *S. cernua* and *S. romanzoffiana* possess membranaceous lips in which the venation is readily apparent. Segregates of *S. cernua* show varying degrees of development of this central thickening. This character can be used in interpreting gene flow in the complex, but it must be used with care, because the fleshy nature of the lip is lost as the flowers senesce on the plant, and occasionally during drying in the press the fleshy condition (especially in older flowers) is altered to the membranaceous. This problem is compounded by the occasional development of basal dilations with senescence or poor preservation in plants normally lacking them. Hence, it is essential that only well preserved material be used, and, if possible, only flowers showing no discoloration should be selected.

At the base of the lip, adjacent to the claw, are located two more or less marginal, conical protuberences. They have been variously termed "callosities" (Ames, 1903, 1904; Correll, 1950); "tubercles" (Case, 1964); "tuberosities" (Luer, 1972; 1975); "calli" (Sheviak, 1973; Sheviak and Catling, 1980); and "nectar glands" (Ames, 1921). Of these possibilities, "tubercles" is perhaps the best. Tubercle variation has been used as a character with varying degrees of emphasis, the extreme case being *Ibidium incurvum* (Jennings, 1906), which was proposed solely on the basis of supposed differences in these structures. Ames (1921) stated that the tubercles of *S. ochroleuca* tended to be longer and more curved than those of *S. cernua*. This is frequently the case, but in some material of *S. ochroleuca* they may be distinctly shortened. In *S. cernua* tubercles vary greatly from the long, curved structures which served as the basis for *Ibidium incurvum* to short, conical nobs. The latter condition is typical of *S. magnicamporum*; *S. odorata* typically bears moderately long, somewhat curved tubercles. In *S. cernua* and *S. magnicamporum*, and probably other species as well, short tubercles elongate greatly as the flower ages, making this already variable character even more difficult to assess.

Variation in floral color can be significant and has been employed by most workers. In typical form, *S. cernua* is characterized by pure white flowers. In contrast, those of *S. ochroleuca* are distinctly yellowish or at least ivory-colored. In *S. odorata* a range of white to ivory is common, with the thickened center of the lip frequently suffused with green or yellow, the latter sometimes quite intensely. *Spiranthes magnicamporum* exhibits a similar range of white to ivory, with the center of the lip usually more or less yellow. Great variation is found in the prairie complex and in Northeastern populations of *S. cernua*.

The use of floral color is complicated by a tendency for the ivory or yellowish condition to be accentuated under more xeric conditions. Specimens of *S. magnicamporum*, for example, when found on dry, exposed prairie, characteristically bear yellowish or ivory flowers, but when they are transferred to the greenhouse produce whiter flowers in subsequent years. Similar results are obtained with some of the races of *S. cernua*. This character is particularly variable in some abnormal material; one cultivated plant (*Sheviak 388b*), for example, in various years has produced pure white, yellow, and green and yellow flowers.

Fragrance varies somewhat in the genus but has been used only rarely. In the *S. cernua* complex, flowers of *S. cernua* are often scentless or very nearly so. Fragrance, when present, is variable, but is generally pervaded by a distinct earthy quality. The characteristically fragrant flowers of *S. ochroleuca* are rather more pungent in the terminology of Fernald (1950). In *S. odorata*, flowers are distinctly fragrant, with a scent varying from like that of fragrant *S. cernua* to a condition suggesting *S. magnicamporum*. Correll (1950) described it as a mixture of vanilla, coumarin, and jasmine. The flowers of *S. magnicamporum* are the most fragrant in the complex, producing a strong scent of coumarin (Sheviak, 1973; Luer, 1975); this scent is also present in *S. romanzoffiana*. Consequently, this character is of interest as a possible indicator of gene flow in the complex, especially in the prairies where the intensely fragrant *S. magnicamporum* contributes its singular scent to its hybrids with *S. cernua*. Such a subjective character (definitive chemical analysis has not yet been technically possible) is, of course, difficult to utilize precisely and uniformly.

Seeds

Leavitt (1900) early determined the presence of polyembryony in *S. cernua*. Curtiss (1893), however, had previously reported normal seeds in this species. This discrepancy stimulated further work, and Leavitt (1907) reported the more general occurrence of polyembryony. Ames (1921) first used this character taxonomically to separate the polyembryonic "wet meadow and bog form of *S. cernua*" from the monoembryonic *S. ochroleuca* stating that it was the only character by which this separation could be reliably achieved. This character is of extreme importance. Since Ames first recognized the monoembryonic nature of the seed of *S. ochroleuca*, the characteristic has been stressed as the principal difference between this species and *S. cernua* (Correll, 1950; Fernald, 1950; Case, 1964; Luer, 1975). The monoembryonic condition in *S. odorata* seems to have largely escaped notice, as only Fernald (1950) mentioned it. One of the principal differences utilized in distinguishing *S. magnicamporum* from *S. cernua* similarly lies in the presence of the monoembryonic condition in the former (Sheviak, 1973; Luer, 1975). Since this variation reflects the cytological condition of the plant (see below), it is of great importance.

The shape of the seed rarely has been used. Ames (1921) described the seeds of *S. cernua* as "balloon-shaped" and those of *S. ochroleuca* as slenderly elliptical. Sheviak (1973) noted the oblong-quadrate seeds typical of *S. magnicamporum* and compared them with the fusiform seeds of *S. cernua*. It is now clear that comparatively short and broad seeds are characteristic of *S. ochroleuca*, *S. odorata*, and *S. magnicamporum*, whereas *S. cernua* produces slender, fusiform seeds. Although variation occurs within taxa and individuals, this character can be of use particularly in cases involving peculiar specimens of uncertain affinities.

Representative seeds are illustrated in Figure 6 and Figure 7.

CYTOLOGY

Polyploidy in natural orchid populations was reported first in *Spiranthes* (Pace, 1914). By study of serial sections, Pace found *Spiranthes lacera* to be diploid and *S. cernua* to be tetraploid, although in the latter case, "no count was entirely satisfactory."

It is thus remarkable, considering the taxonomic complexities of the genus and the controversy which has surrounded it, that until the present study no one had conducted cytological studies in an effort to clarify relationships. The available literature reports are presented in Table I.

In the present study, the majority of counts have been obtained from root tips. Root tips are collected during the morning. Some evidence for mitotic periodicity has been noticed, for root tips obtained before 8:00 a.m. tend to exhibit abundant prophase nuclei and few or no metaphase figures. Root tips are treated with a saturated aqueous solution of monobromonaphthalene at room temperature for four hours. During hot weather temperatures must be maintained below 25°C for best chromosome condensation. Alternatively, roots may be treated at about 4° for periods of twelve to eighteen hours, but results are not so consistently satisfactory. Initially, 8-hydroxyquinoline was used, at both .002M. and .004M., but the results were not satisfactory.

Following this treatment the root is fixed for twenty to thirty minutes in Carnoy's solution. Longer periods retard chromosome spreading. Farmer's solution was originally used, but Carnoy's promotes better spreading.

Following fixing, the root is stored in 70% ethanol in a freezer or prepared for immediate squashing. For this it is hydrolized in 1N. HCl at 55° to 60°C. for eight to fifteen minutes. Although the longer periods allow significantly better squashing, hydrolyzing in excess of nine minutes sometimes prevents staining.

For staining, aceto-lacmoid prepared as indicated by Darlington & LaCour (1969) and Melquist and Clovis (1957) is used. Aceto-carmine and orcein, both after and during hydrolysis, proved unsatisfactory, as did the Fuelgen method.

I have not had success with anther preparations. No meiotic figures have been seen, and the only count obtained from anthers was from a mitotic tapetal division in *S. odorata*.

For field use, immature ovaries are used. Suitable buds include all sizes from those near anthesis to the smallest which have a distinguishable ovary. The buds are treated with monobromonaphthalene solution and fixed in Carnoy's solution for 20 to 30 minutes. Buds are hydrolyzed for 15 minutes, and the ovaries then dissected to remove the immature ovules; the ovules are stained and squashed in the same manner as root tips.

Ovaries were selected as likely sources of mitotic figures due to the great abundance of developing ovules. The quality of the figures is in general somewhat lower than in root tip preparations, but this is often made up for by the comparative abundance of material. Meiotic figures are also commonly present, and these preparations have been the sole source of meiotic information obtained in this study.

The interpretation of cytological data has been straightforward. Endopolyploidy has not been found in *Spiranthes*. Counts obtained from root tips and flowers agree in chromosome number and correlate with meiotic counts. Although endopolyploid cells may occur in tissues not studied, they do not contribute difficulties to cytological work on the tissues utilized in this study.

Hypoploid cells, however, are consistently present in the root tips of tetraploids. They generally exhibit chromosome counts somewhat above the triploid level, with a frequent range of about 47 to 52 chromosomes. The cells are unusually large and unstaining and increase in importance in the root tip as the root nears cessation of growth in the summer. One division figure was found which provides a possible explanation of the origin of hypoploid cells. This was a late anaphase figure in which one daughter complement was organizing into two groups, one with approximately two-thirds of the chromosomes. Possibly this larger hypoploid aggregation organzies a normal nucleus and undergoes later mitotic division.

True B-chromosomes have not been clearly demonstrated in orchids. Vij and Vohra (1974) reported B-chromosomes in some specimens of *S. autumnalis*, but correlated these with morphological variation, suggesting that this designation might be inappropriate. In the present study, no evidence of B-chromosomes was found.

The chromosome counts obtained in this study and some meiotic information are presented in Table II. As can be seen from this table, the *S. cernua* complex has been found to consist of three diploid species, *S. odorata*, *S. ochroleuca*, and *S. magnicamporum*, with 2n=30. A large tetraploid complex, with 2n=60, includes *S. cernua*. The putative hybrid "low prairie race," the two single-ranked northeastern forms, and some other northeastern plants have been found to be triploids. A few aneuploids (hypertetraploids) have also been found.

Photographs documenting the chromosome counts of the species dealt with in this work and other squashes of interest are assembled in Figures 1–5.

From these findings it is evident that Paces' (1914) material was, indeed, referable to *S. cernua*, but that Tanaka's (1965, 1969) was not and probably was a member of one of the diploid species in the complex. The report by Smith (1964) of a count of 2n=*ca.* 50 for *S. cernua* is inaccurate. The voucher for this collection is a typical member of the prairie complex, and many other typical collections have been made at the locality. I have collected there and found the plants to be identical with *Sheviak 962* which was collected only a few miles away. Unfortunately, the cytological specimens I collected at Smith's locality proved unusable. It is clear, however, that Smith's count is in error. It is possible that his preparation was not adequate, but most likely he based his report on hypoploid cells. These are more easily counted than normal cells because of their lower chromosome number and larger size and hence are more apt to be chosen for counts than normal tetraploid cells.

The meiotic information obtained in this study is limited but highly significant. Diploids show regular meiosis with perfect bivalent formation. In contrast, tetraploids generally display varying degrees of meiotic irregularity (Figure 4). Quadrivalents are common. Chromatin bridges indicate the presence of inversions in some plants. Lagging chromosomes are occasionally seen. The presence of translocations is indicated by complex pairing including branched chains and multivalents above the quadrivalent level. Considering the complex pairing in the tetraploids examined in this study, it seems likely that they are segmental allotetraploids.

Some of the tetraploid races studied, however, frequently exhibit exceptionally good pairing. Figure 5 shows first meiotic metaphase and anaphase of *Sheviak 388b*, an aneuploid (2n=61) derivative of one of these races. The metaphase shows 30 bivalents, with a few secondary associations, and one very small univalent. Similarly, in the anaphase, one daughter complement shows 30 chromosomes plus one out of the plane of the others and lagging slightly.

These cytological data have provided the basis for an understanding of the *S. cernua* complex as discussed below. The presence of translocations and irregular pairing has been of major importance in the deduction of the origin of some members of the complex. These phenomena will be treated in detail in a subsequent paper.

GUARD CELL MEASUREMENTS

Guard cell measurements were undertaken in an effort to extend cytological data to herbarium material and to aid in the determination of problem specimens. Measurements were obtained from abaxial surfaces of floral bracts; usually a single bract was chosen from each specimen. Usually ten, but occasionally up to fifty cells were measured and the mean determined. Measurements were made on over 300 specimens; these included plants for which chromosome numbers were known and others which had been determined on the basis of morphological characters. The ranges in mean measurements were:

S. magnicamporum & *S. ochroleuca*	29.8-38.4 microns
S. odorata	35.9-40.8 microns
3n low prairie race	31.2-43.9 microns
known and apparent tetraploids	34.6-47.4 microns

Although exhibiting a continuous range of variation, these measurements do have a certain applicability. The ranges exhibited by diploids and tetraploids overlap widely, but the smaller measurements for *S. magnicamporum* and *S. ochroleuca* and the larger tetraploid figures are distinct. This situation permits the use of guard cell measurements as a character.

Significantly, a tendency was noticed for the largest cells to occur in specimens which are difficult to determine on morphological grounds, and a distinct correlation between hybrid-like morphology and large guard cells is evident. This situation is often helpful in determination. Conversely, very small cells typical of diploids have been found in some hypertetraploid, morphologically abnormal material; these specimens are readily determined by consideration of gross morphology, and hence guard cell size is not likely to contribute to misidentification of these plants. This apparent cytogenetic influence on guard cell size is a significant phenomenon and will be dealt with in a subsequent paper.

APOMIXIS

Leavitt (1900, 1901) was the first to recognize the presence of polyembryony in *S. cernua*. His observations further indicated the development of seed without pollination, and he reported the abortion of pollen tubes in experimentally pollinated flowers. Schnarf (1929) reported *S. cernua* to be an apomict. Stebbins (1941), however, questioned this conclusion. To clarify the situation, Swamy (1948) studied embryogenesis in *S. cernua*. He found that the polyembryonic condition was due to the adventive development of two to six embryos through mitotic division of the inner integument.

Swamy based his work largely on material from the northeastern United States, with greatest emphasis on populations in eastern Massachusetts. He concluded that *S. cernua* was comprised of three races. Members of the first reproduce sexually. Seeds were monoembryonic, the embryo always developing from a fertilized egg. The second race was wholly apomictic. Adventitious embryony resulted in seeds containing two to six embryos of nucellar origin. Occasionally nucellar mitotic division began before the completion of meiosis in the adjacent megaspore mother cell. Embryo sac development usually was arrested at the four cell stage. Microsporogenesis, in contrast, proceeded normally, but the mature pollen degenerated and became infested with "a saprophytic fungus" by the time of anthesis. The third race was "intermediate" in its behavior. Capsules normally contained a mixture of seeds of sexual and apomictic origin. The apomictically produced seed of this race, however, contained not more than three embryos. Pollen was normal and functioned in the fertilization of sexual ovules. Significantly, in this race adventitious embryos did not develop in ovules containing a functional embryo sac, and they developed in sexually sterile ovules only following fertilization of the normal ovules. The relative proportion of apomictically produced seed varied from 25% to 65% in various individuals.

Using embryo number as the critical character, Swamy then attempted to determine ranges and relative importance of the three races. From examination of herbarium specimens he concluded that by far the greatest proportion of specimens were wholly apomictic, and that sexual and "intermediate" plants were considerably less important (520 and 412 plants, respectively, out of a total of 5,000) and essentially restricted to the northeastern United States.

My own experience with cultivated material early confirmed the apomictic nature of *S. cernua*. Not only did plants of this species characteristically produce seed without pollination, the pollinia removed and pollinators excluded, but buds from which the entire column had been excised continued to develop and formed normal capsules with abundant seeds. In contrast, plants of what was later described as *S. magnicamporum* were found to require pollination for seed production. Seeds in these plants were monoembryonic. Subsequent studies showed the presence of monoembryony and the absence of apomixis in *S. ochroleuca* and *S. odorata*.

Cytological study has been of great importance to an understanding of the significance of reproductive mode in the complex. Study of numerous specimens from throughout the range of the complex has shown diploids to be uniformly sexual and to produce strictly monoembryonic seed (Figure 6). Conversely, polyploids exhibit varying degrees of apomixis and correspondingly variable percentages of polyembryonic seed (Figure 7). The earlier report (Sheviak, 1973) of polyembryony in specimens of *S. magnicamporum* from some portions of its range has been found to be based on polyploid members of the prairie complex. Very recently, Catling, (1980, 1981, 1982) has reported polyembryonic seed and adventitious embryony in *S. magnicamporum*, *S. ochroleuca*, and *S. odorata* toward the northeastern range limits of the species. These reports would appear to be based on polyploids, a conclusion supported by examination of some of Catling's material. He has reported (Catling, 1980), however, a diploid chromosome number for a single apomictic specimen of *S. magnicamporum*; this count supports his conclusions and indicates that the correlation between ploidy level and reproductive mode is not absolute. Cytological study of these plants is needed. It is apparent, however, that apomixis in diploids is very restricted.

Although Swamy's work is basically sound, some error in interpretation is apparent now that I have made protracted observations on cultivated material and have been able to study the plants over much of their ranges. The most obvious flaw is in his establishment of three races based on reproductive mode. The actual situation is much more complex. It is now apparent that sexuality is a characteristic of more than one taxon within the *S. cernua* complex. Furthermore, Swamy's utilization of relative number of embryos in polyembryonic seeds as a means to distinguish obligate and facultative apomicts is of very dubious reliability when one considers the great diversity of genotypes and habitat requirements as well as the wide range of *S. cernua*. Indeed, some allotriploids apomictically produce abundant seed in cultivation, but a large proportion of such seed is monoembryonic, indicating a more complicated situation than that proposed by Swamy. There is also some question as to the absolutely obligate nature of apomixis indicated by Swamy for his "asexual race." My observations indicate that, although some obligate apomicts do occur, most notably certain teratological plants, the majority of plants within *S. cernua* are capable of some sexual reproduction.

An indication of variation within *S. cernua* has been obtained from comparison of flowering behavior between clones and of the same clone over several years of cultivation. With the exclusion of pollinators a striking difference is seen. In some plants enlargement of the ovary is precocious, and flowers open on developing capsules. In such plants, flowers are open often for only a day or two. Such behavior is to be expected as an extreme development in Swamy's "asexual race," in which adventitious embryo development begins at the time of first meiotic prophrase. It is doubtless significant that such races frequently are stable over wide areas. In contrast, in the majority of plants of *S. cernua* which I have examined, flowers remain open and functional for a protracted period. Thus, in the absence of pollination, an entire inflorescence may remain in good condition for two weeks before swelling of the ovaries is seen, followed shortly by collapse of the perianth. This would be the expected behavior of the "intermediate race" of Swamy, although he makes no mention of it. In my experience, races exhibiting such floral behavior are morphologically variable.

Swamy's report of pollen abortion and fungal infestation in his asexual race appears to be unrelated to reproductive mode. Pollen abortion appears to be influenced by the environment; greenhouse studies have suggested that this phenomenon and irregularities of stipe and disc formation are associated with high ambient temperatures. *Spiranthes ochroleuca* and various other species exhibit the same anomalies as *S. cernua*.

The correlation of apomixis and polyploidy, and hence of polyploidy and polyembryony, has been most useful, for it has aided the recognition of polyploids in the herbarium. Care must be taken with seed characters, however. It should be noted that embryo number merely provides an indirect means of assessing the underlying character, reproductive mode. Hence, observation is directed at irregularities in seed development associated with adventitious embryony (Figure 7). Monoembryonic seeds with extruding or externally developed embryos (as figured by Swamy) and disassociated embryos lacking testae are as indicative of apomixis as is polyembryony. Great variation is seen in the expression of seed and embryo characters in apomicts, and only in part does this reflect differing percentages of sexual and apomictic processes. Apparently normal, monoembryonic seeds are characteristically produced by some obligate apomicts; irregularities in such plants must be sought carefully. No evidence, however, for the occurrence of polyembryony in obligately sexual individuals has been found. Polyembryony and other irregularities are good indicators of apomixis; their apparent absence is somewhat less significant. In either case, such characters are best used in conjunction with other characters for determination.

TERATOLOGIES

A significant percentage, in some areas the majority, of the variation in floral characteristics in the *S. cernua* complex involves varying degrees of expression of two abnormal conditions.

One of these, peloria, reaches its extreme development in the prairie complex, where plants bearing truly peloric flowers are frequent and often characteristic components of some populations. In these plants the lip is scarcely if at all differentiated from the petals. Some of the most significant variation in the prairie complex involves the partial suppression of the lip, and similar semipeloria is seen elsewhere in the range of the complex, especially in the Northeast. In this region an opposing peloric tendency, the elaboration of petals toward characteristics of the lip, is also sometimes seen.

The second abnormality of interest here is the failure of floral buds to open. This condition suggests cleistogamy and has been noted as such on some herbarium sheets. Such use of the term is not appropriate, however, as pollination does not occur, and seed production is wholly apomictic; I will refer to this phenomenon as "cleistapogamy." Cleistapogamy is best developed and most important in the prairie complex, where it occurs in two basic forms here referred to as obligate and facultative cleistapogamy. Plants exhibiting the former condition are always cleistapogamous and produce no pollen. They are, additionally, wholly peloric and the perianth retains a uniform green color. The behavior of facultatively cleistapogamous individuals, however, varies from year to year and even between flowers on the same inflorescence. Often flowers are normal, but in some years they may be totally cleistapogamous. Often a mixture of conditions and degrees of intermediacy occurs.

Floral form in facultatively cleistapogamous individuals may be influenced by the environment, much as cleistogamy often is. In cultivated plants I have noticed a more frequent production of cleistapogamous flowers during hot weather. This has been particularly true of *Sheviak 388b* which has been in cultivation for a number of years. This plant has produced either normal or cleistapogamous flowers in various years, or occasionally a mixture of the two. During one hot August, the plant produced an inflorescence which had developed a number of cleistapogamous flowers but was still largely in bud when cooler weather arrived. Under the cooler temperature regime the remaining buds developed into normal flowers. Most remarkably, the perianth segments of some of the previously formed cleistapogamous flowers elongated apically and diverged, such that the essentially closed flowers were open at the apices. The remaining cleistapogamous flowers and the cleistapogamous portions of the newly modified ones were uniformly green; the elongated apical segments of the latter varied through yellow to white. The normal flowers higher on the spike were wholly white. The apparent correlation of cleistapogamy in facultative individuals with environmental variables, most likely including air temperatures, parallels abnormalities in pollen and pollinaria formation reported earlier (Sheviak & Catling, 1980).

Facultative cleistapogamy occurs not only in the prairie complex but is occasionally found elsewhere in the *S. cernua* complex, especially in the Northeast. The partial expression of cleistapogamy also appears to be reflected in the floral shapes of certain members of the *S. cernua* complex. These plants are characterized by variously cylindrical to urn-shaped flowers which open partially but never assume the gaping form typical of their relatives. Such plants are important components of the complex in the northeast and the prairies, and often contribute strikingly to the variation exhibited by a given population.

Both peloria and cleistapogamy have proven to be correlated with, and doubtless resultant from, aneuploid conditions. The origins and relationships of these phenomena will be treated in detail in a subsequent paper.

POLLINATION BIOLOGY AND HYBRIDIZATION

In the original work on *S. magnicamporum* (Sheviak, 1973), experimental crosses between this species and *S. cernua* were found to be unsuccessful. Additional crosses more recently were made utilizing these species and *S. odorata* and *S. ochroleuca*. These experiments were conducted primarily to determine compatibility of the diploids, but supplemental *S. cernua* crosses also were made. The results are presented in Table III. These results indicate that the species are partially isolated genetically, although occasional crosses are successful. This isolation is particularly significant in the Orchidaceae, which is noted for ease of hybridization. All crosses involving *S. cernua*, however, employed the diploids as pistillate parents; reciprocal crosses utilizing *S. cernua* as the pistillate parent were not attempted due to the apomictic nature of this species. If the observed isolation results from a lack of stimulation of fruit development, such crosses would provide a ready means of bypassing this mechanism and would allow unidirectional gene flow into *S. cernua*. The poor seed production of even the larger capsules obtained in the present crosses indicates, however, that other factors are operative as well.

Further isolation due to possible pollinator recognition of *S. cernua* and *S. magnicamporum* was earlier hypothesized (Sheviak, 1973). This suggestion was based on the very different aspects of the inflorescences of these plants and also the singular, intense fragrance of *S. magnicamporum*. Observations of pollination of *Spiranthes* in the field are rare and do not clarify the situation. Table IV presents the available reports.

Robertson (1893) reported pollinia of *S. lacera* to be born on the mandibles of *Calliopsis andreniformis* and *Megachile brevis*. I have found similar placement of *S. cernua* pollinia on *Bombus* species. Van der Pijl and Dodson (1966) suggested that the reports of *Bombus* on the small-flowered *S. spiralis* (Darwin, 1877) and *S. lacera* (Robertson, 1893, 1928) were due to misidentifications or casual visits. Robertson, however, specifically reported these as pollinating, and Van der Pijl and Dodson have accepted his determinations elsewhere. They have further stated that Godfery's (1931, 1933) reports of *Bombus* on *S. romanzoffiana* clearly arose from a chance visit. I have found *Bombus* to be the characteristic pollinators in the *S. cernua* complex.

Some significant observations were made in the greenhouse during the present study, when in one year the cultivated collection was actively visited by specimens of *Bombus impatiens*. Because of the arrangement of the collection, the bees most easily passed among members of the same species, but they were seen to move between *S. cernua* and *S. odorata* and between *S. cernua* and *S. ochroleuca*. Pollination was affected. Only one specimen of *S. magnicamporum* bloomed at this time and it was bagged for hybridization experiments, so no observations were made on this species. The available observations, however, suggest a lack of pollinator discrimination. Additionally, it should be noted that in *Spiranthes* the granular nature of the pollinia allows several flowers to be pollinated by the pollinia of a single flower, pollen being progressively removed by several flowers. This, then, would increase the effectiveness of even rare interspecific visits by individual bees.

ECOLOGY

The wide range of the *S. cernua* complex, extending approximately 2,700 kilometers north from southern Florida and 3,800 kilometers west from the Atlantic coast, presents a great array of environmental conditions and encompasses a number of major biomes. The ecological requirements of the different members of the complex vary accordingly. In common, however, they all exhibit an intrinsic colonizing habit and heliophilic tendency. They are predominately plants of open ground and typically colonize disturbed sites. They may appear within a few years of excavation or similar major disturbance, rapidly increase in abundance, persist for an indefinite period, and then decline and disappear as successional changes alter the site. Other forms of disturbance which serve to arrest succession, such as mowing, grazing, or burning, often promote the indefinite persistence of the species in areas previously disturbed or originally in a natural condition. Upon this fundamental nature are imposed the limiting edaphic and climatic requirements of the various members of the complex, yielding a considerable range of habitats utilized.

The most southeasterly range is occupied by *S. odorata*, an essentially coastal species occurring from eastern Texas to Florida and Delaware (Figure 8). Within the *S. cernua* complex the ecology of this species is in two respects unique. *Spiranthes odorata* characteristically occupies swampy situations subject to at least periodic inundation and occasionally occurs as an emergent aquatic in permanently flooded sites. Such behavior is unknown in the rest of the complex. *Spiranthes odorata* is also unusual in its frequent occurrence in forested sites, and the species is a characteristic plant of swamp forests. Frequency of anthesis is low in such sites, however, and in the deepest shade few plants bloom. Typical of the rest of the complex, *S. odorata* commonly also occurs in open situations in clearings and ditches and along trails and roadsides. Under such conditions it blooms abundantly.

This species also occurs in natural marshes, often under tidal influence, in fresh or brackish water. Soils are unusually diverse, varying from peat and muck to rather low-organic sands, usually of subacid reactions. In the Florida Everglades, and perhaps elsewhere, soils are highly calcareous, structureless, and high in clay.

Spiranthes ochroleuca is more characteristic of the *S. cernua* complex. Essentially northeastern in distribution (Figure 9) it is a plant of rather xeric open communities under natural or disturbed conditions. It is commonly found in sterile openings in scrubby pine and oak woodland, on rock out-croppings, in old fields, and on the upper portions of roadcuts. It commonly occurs in coastal sites exposed to occasional salt spray, which may promote the occurrence of the species by maintaining open conditions. Soils are characteristically acidic and vary in texture from sand to clay loams. Organic matter is commonly very low, but locally may be high.

Spiranthes magnicamporum is a prairie plant with an essentially Midwestern distribution (Figure 10). Its range corresponds in large part to the distribution of tallgrass prairie, with disjunct populations in prairie relicts to the east. To the west, it is also known from disjunct stations in the upper Rio Grande valley and the mountains of northern New Mexico. This species occurs in xeric to mesic grassland. The most acutely drained, exposed sites on loess and dolomite bluffs and sand ridges are occupied in the eastern portion of its range; the further west the species occurs, the progressively more mesic are the sites occupied until, at its western limits, it is dependent on relatively constant groundwater supplies and occurs in marshes and fens.

Reaching a peak of abundance in open communities, *S. magnicamporum* is comparatively rare in dense, undisturbed grassland. The species is most prevalent in the low open prairie communities developed on sand and dry bluffs, and it responds favorably to a variety of forms of disturbance which serve to produce similar conditions; it is often particularly abundant under light mowing and grazing regimes. Soils supporting *S. magnicamporum* are uniformly calcareous and minim- to subalkaline. Textures range from sands to clay loams, with organic matter ranging from essentially absent to high; rarely the species occurs in mucks.

The range of the remainder of the complex nearly includes the ranges of the three diploids, apparently avoiding only Florida, New Mexico, and the Dakotas (Figure 11). Its ecology is correspondingly varied.

In the Northeast, the Great Lakes region, and along the Appalachians and Atlantic Coast, *S. cernua* occurs in a variety of moist to rather wet open sites. Under natural conditions the species occurs in open meadows, marsh borders, and bogs and fens. It is very commonly found in roadside ditches, abandoned borrow pits, moist roadcut banks, and in pastures and lawns. Populations of many thousands of plants may develop in small disturbed sites.

These eastern populations characteristically occupy sandy soils exhibiting a range of development and organic matter content from raw sand to sandy peats and mucks; infrequently true peats and mucks and finer textured soils are utilized. Reactions are most commonly medi-or subacid, but vary to minimalkaline.

The sand-inhabiting *S. cernua* populations are replaced very quickly along the northeastern margin of the prairie and are rarely encountered within the prairie region proper, where they are replaced by various members of the prairie complex. Members of the prairie complex occur usually in open prairie and prairie-like communities. Natural communities often support only scattered individuals, but under light mowing or grazing regimes the plants may become very abundant. Excavated sites, shallow roadside borrow ditches, and railroad rights-of-way are often colonized, especially if prairie-like communities develop and are occasionally mowed or burned.

Soils range widely from gravelly sands through clay loams and mucks; various loams are most important. Reactions vary from subacid and occasionally mediacid to minimalkaline.

In the forested region to the southeast of the prairies, a member of the complex occupies habitats similar to those of *S. ochroleuca* in the Northeast. Under natural conditions it occurs in dry open woodland on bluff crowns and ravine rims. It is very rare under such conditions and is more common about the margins of openings, such as prairie borders. This plant is characteristically a colonizer of old fields undergoing succession to oak-hickory and mixed hardwood-pine forests; consequently, it has been referred to as the "old field ecotype" (Sheviak, 1974b).

Soils are loams and silt- and clay loams of mediacid to very highly subacid reaction.

DISCUSSION

Once morphological variation is analyzed in terms of ploidy level, the *S. cernua* complex is seen to be composed of three distinct, sexual diploids and a highly variable, apomictic polyploid complex. The three diploids, *S. odorata*, *S. ochroleuca*, and *S. magnicamporum*, present a reticulum of character combinations, suggesting that they are closely related. Additionally, no other species are known in which occur an essentially ovate, fleshy lip and dense, "multiranked" inflorescence, suggesting that they are more closely related to each other than they are to any other species. Considering the great differences in ecological requirements of these plants and their allopatric distributions together with their morphological distinctions, it is clearly best to treat them as distinct species. This conclusion is further supported by breeding experiments discussed previously.

Once these three diploid species have been recognized, the problems of determination and interpretation are seen to be largely at the tetraploid level. Tetraploids exhibit a great range of morphological combinations and include what has classically been treated as *S. cernua* (Figure 12). They characteristically exhibit a lip bearing a strong basal dilation. This feature is present in the great majority of polyploids and is nearly always present in plants characteristic of *S. cernua* in other respects; hence, it is considered to be a very important, unifying characteristic of the complex. The variation exhibited by the tetraploids includes character combinations seen in the diploids (Figures 12 and 13a). Occasional extreme plants may very strongly resemble one of the diploids, but I have not encountered any that was entirely characteristic of a diploid species.

The inclusion in a variable tetraploid assemblage of characteristics of related diploids suggests the possibility of unidirectional gene flow from the diploids to the tetraploids. The necessary input of genes might occur in any of several ways. Autotetraploid individuals could provide a means of bridging the differences in ploidy level, and autopolyploidy is well-known in the Orchidaceae. The morphologically extreme tetraploids mentioned above suggest autotetraploids, but these and all other tetraploids studied have always shown at least some morphological features of *S. cernua* and meiotic characteristics of segmental allotetraploids. Although the effects of polyploidy itself on the genomes are unknown, the available evidence indicates that all tetraploids are members of a single tetraploid complex, and autotetraploids are not known to occur.

Gene flow might be by way of allotriploids. Vardi (1971) has shown that such triploids frequently possess a limited fertility. In the present study, the triploid low prairie race exhibits characteristics of *S. magnicamporum* and *S. cernua* and hence is apparently of hybrid origin. This race, however, occupies a habitat not utilized by tetraploids (and only rarely by *S. magnicamporum*) and is not a likely triploid bridge for such gene flow. In the Northeast, mixed populations of *S. ochroleuca* and *S. cernua* are known to support occasional triploids (Sheviak and Catling, 1980); these plants might be involved in unidirectional gene flow in such populations.

Gene flow may also occur directly from diploids into tetraploids, for allotetraploids are possible products of crosses involving unreduced gametes. The prodigious quantity of seed produced by orchids makes such occurrences likely, and they are frequently found in commercial orchid breeding. Additionally, Hagerup (1947) found in several European orchids that eggs were sometimes fertilized by two nuclei from one pollen tube, or by nuclei from more than one tube. Such unusual occurrences were found to be present in most ovaries studied. This behavior would permit direct gene flow from diploids into tetraploid populations.

Whether such gene flow accounts for the variation seen in tetraploids is another matter, however. Attempts at verification have met with varying degrees of success. Breeding experiments, as discussed earlier, have not satisfactorily indicated its likelihood. Pollen sterility determination has been ambiguous due to technical problems involving the breakup of pollinia and due to fundamental questions relating to the apomictic process and polyploidy. Chemical characterization of fragrance components has met with technical problems and flavonoids have been found to be in such low concentrations that samples cannot be obtained from single individuals as is necessary in the complex populations under study.

Cytogenetic data have been more revealing. The presence of translocation heterozygotes in the intermediate prairie complex could indicate hybrid ancestry. More significant is the presence of cytologically based teratological forms in the prairie complex, in the zone of contact of *S. cernua* and *S. magnicamporum* (Figure 13b), and in mixed populations of *S. cernua* and *S. ochroleuca*; the occurrence of these forms, and hence the presence of the meiotic irregularities producing them, in populations of morphologically intermediate plants and in situations permitting hybridization is strong evidence for the presence of gene flow.

Analyses of morphological variation further indicate the occurrence of widespread gene flow. Multivariate statistical analyses performed on populations of *S. ochroleuca* and *S. cernua* in the Northeast (Sheviak & Catling, 1980) have suggested the possibility of unidirectional gene flow between these species. In these analyses known triploids and one aneuploid teratological specimen were determined to be well within the variation pattern of the tetraploids, suggesting introgressive dilution of the tetraploid gene pool.

Another analysis, employing a relatively large sample but rather qualitative characters, has yielded particularly suggestive results. It employed populations of *S. cernua* from the western Great Lakes region, where the species exhibits, to varying degrees, characteristics of *S. magnicamporum*. Three characters were chosen: the shape and texture of the lip and the presence or absence of leaves at anthesis. These characters were useable on most specimens of reasonable quality and were readily assessed. Figure 14 presents the findings of this analysis. These graphs are based on 189 specimens from principally northern and western Illinois, northern Indiana, Wisconsin, and Michigan; a few were included from Minnesota and the Lake Erie regions of Ohio, Pennsylvania, and Ontario. Specimens were chosen from every sheet of appropriate locality in my own collection and the herbaria of the Milwaukee Public Museum, the University of Illinois, and the Illinois Natural History Survey. One specimen per sheet was chosen except in variable populations in which a range of morphotypes was utilized. Lips were rated for shape and texture on arbitrary scales of one to five. An ideally ovate, non-dilated and strongly fleshy lip of *S. magnicamporum* was assigned a value of (1, 1). Extreme development of *S. cernua* was considered to be strongly dilated basally and wholly membranaceous; this was ranked (5, 5). Intermediate conditions were rated accordingly.

The scatter diagram in Figure 14a shows these characters plotted as leafy or leafless. Chromosome counts for individuals exhibiting particular combinations are given where determined. The leafless conditions ranked from (1, 1) to (2, 2) are within the range of variation of *S. magnicamporum*. The leafy *S. cernua* is more difficult to characterize, but (5, 5) to (4, 4) is a likely range. All other combinations suggest hybridization. Even if *S. cernua* is allowed a greater range in lip morphology, apparent recombinations are evident.

Complicating interpretation is the inclusion of triploids in the sample. These cannot be reliably determined, and hence any attempt to exclude them would invite the introduction of error. Present information, however, indicates that the majority of the leafless plants in the range (5, 5) to (4, 3) and probably others are triploid. Such plants as the leafless (1, 4) appear from guard cell measurements and gross morphology to be tetraploid.

When the two lip characters are combined in a hybrid index by multiplying them together, a striking pattern is disclosed (Figure 14b). In the left-hand graph, the line plots two-point sliding means for the total population; to the right these means are plotted separately for the leafy and leafless members. From these plots the influence of the leafless triploids is clearly seen in the secondary hump in the leafless plot. Most significantly, a very rapid drop with departure from characteristics typical of *S. magnicamporum* is seen. A much more gradual climb into typical *S. cernua* is evident. This is precisely what is to be expected in unidirectional introgression involving establishment of allotetraploids and subsequent backcrossing to the tetraploid parent.

The results of these analyses indicate, first, that much of the variation of *S. cernua* in the western Great Lakes region may be due to introgression from *S. magnicamporum*, and in the northeast from *S. ochroleuca*. Secondly, this suggests that the variation of *S. cernua* as a whole might be due to introgression. These findings indicate that the hybrid-like morphologies seen in the prairie complex are indeed due to hybridization. Since the much more subtle infusion of genes from *S. magnicamporum* to *S. cernua* in the lakes region appears to be a classic case of unidirectional introgression, there is little reason to suspect that the apparent hybrids in the prairies are not also of hybrid origin. Certainly the intermediate morphology of the triploid low prairie race supports this conclusion. It thus appears to be an allotriploid agamic race, as was originally proposed on morphological and ecological grounds before cytological data were available in the complex (Sheviak, 1973). Recent work on pollen characters by Balogh (1979) provides additional support to these conclusions. Her studies have included one prairie complex member (*Palmer 3263*); its pollen is reported (personal communication) to approach that of *S. magnicamporum*, a condition which again suggests hybridization.

Evidence for gene flow from *S. odorata* to *S. cernua* is, at the present time, limited. The clearest example is in one collection from, significantly, outside the known range of *S. odorata* on Long Island (*F.A. Mulford s.n.*; NY). Another collection, from southern Mississippi (*J.T Stewart s.n.*; F#115658), may be referable to the prairie complex, as the sheet bears two very dissimilar specimens, one very similar to *S. magnicamporum* but bearing polyembryonic seeds. The second suggests *S. cernua* florally and *S. odorata* vegetatively. It could, however, have attained its robust condition as a segregate of a prairie complex population. Additionally, the report of apomixis in *S. odorata* by Catling (1982) may indicate the occurrence of allopolyploids; these plants warrant further study.

It would appear that *S. cernua* hybridizes with related diploids, and that this hybridization is responsible for much of the variation seen in the species. Since autopolyploidy has not been found, all tetraploids must be treated as *S. cernua*. Through hybridization and recombination a great range of forms has developed; some of these very closely resemble the diploid species which contributed genes to the complex. The evolutionary nature of the complex and the adaptive significance of this hybridization will be the topic of a subsequent paper. It can be concluded here, however, that the incorporation of genes of related species is a fundamental characteristic of *S. cernua*; it is, consequently, a compilospecies (DeWet and Harlan, 1966). This conclusion is basic to the taxonomic treatment which follows.

TAXONOMIC TREATMENT

The difficulty encountered with morphological characters in the *S. cernua* complex is not unique. Stebbins (1971) has stated, "The morphological criteria used by taxonomists . . . are obviously inadequate guides to the evolutionary origin of many plant populations." It is the polyploid complex, like the one centering on *S. cernua*, that frequently presents the greatest problems for the taxonomist. Significantly, segmental allopolyploids are characteristically most difficult taxonomically, and small complexes, with two or three diploids, are usually classified as a single species by conservative taxonomists (Stebbins, 1950). Tetraploids are often placed with the diploid species which, through gene flow, they most closely resemble, rather than with the rest of the tetraploid complex of which reproductively they are a part (Grant, 1971). The history of classification of the *S. cernua* complex clearly reflects these problems.

The almost complete isolation of the diploids in the *S. cernua* complex and their morphological divergence dictates that they be treated as distinct species. An entirely satisfactory treatment of the polyploids is more elusive, however. This difficulty is a direct result of the combination of hybridization and apomixis present above the diploid level. Although apomixis preserves distinct hybrid lines, the hybrid nature of much of the tetraploid complex dictates that hybrid ancestry not be the basis for formal recognition, and even allotriploids cannot be accorded special status. Although taxonomic recognition of ecotypes and similar segregates is often desirable for greater precision, in the present case such a treatment does not appear reasonable. Considering the difficulty in determination even at the specific level, recognition of infraspecific segregates is impractical. *Spiranthes cernua* is best treated as a polymorphic compilospecies without formal recognition of infraspecific taxa.

Spiranthes odorata **(Nuttall) Lindley,** Gen. Sp. Orchid. 467. 1840.

Basionym: *Neottia odorata* Nuttall, Journ. Acad. Phila. 7: 98. 1834.

Gyrostachys odorata (Nuttall) Kuntze, Rev. Gen. Pl. 2: 664. 1891.

Gyrostachys constricta Small, Bull. Torrey Bot. Club 25: 609. 1898.

Gyrostachys triloba Small, Bull. Torrey Bot. Club 25: 610. 1898.

Ibidium odoratum (Nuttall) House, Muhlenbergia 1: 128. 1906.

Triorchis odorata (Nuttall) Nieuwland, Am. Midl. Nat. 3: 123. 1913.

Ibidium trilobum Small, Fl. SE U.S. ed. 2. 320. 1913.

Triorchis triloba (Small) House, Am. Midl. Nat. 6: 206. 1920.

Spiranthes cernua (Linnaeus) L. C. Richard var. *odorata* (Nuttall) Correll, Bot. Mus. Leafl. Harvard Univ. 8: 79. 1940.

TYPE: ["along the borders of the Neuse River . . . on the wet and muddy shores" (Nuttall, 1834)], Newburn, N.C.! (PH).

Typification of synonyms:

Gyrostachys constricta Small: Marshes, Louisiana (Small, 1898), Oct., *Dr. Hale 444!* (NY).

Gyrostachys triloba Small: Ft. Meyer, Florida, Dec. 1891, *J. H. Simpson 368!* (NY).

Erect herb, 15–100 cm. tall; pubescent above, at least some trichomes capitate. Roots few, fasciculate, fleshy, slender, 10–30 cm. or more in length, horizontally spreading, stoloniferous. Leaves persistent, few to several, basal and extending partially up the stem, the basal short-petiolate or sessile, cauline sessile, elliptical to oblong-oblanceolate, fleshy and aerenchymatous, lucid to rather dull, the longest up to 4 x 40 cm. Inflorescence densely flowered, orthostichies usually obvious, sometimes obscure, vertical to commonly spiraled. Flowers white to ivory, the lip often yellow or greenish centrally. Perianth ringent to urceolate, 4–15 mm. long, the stout, sessile ovary somewhat shorter. Sepals lanceolate, the lateral usually spreading or sometimes inward-arcuate, the dorsal with the apex recurved. Petals lanceolate, adherent to the dorsal sepal, apices recurved. Lip fleshy, rhombic-ovate to ovate, the margin tapering to a subacute apex, crenulate, recurved, basal tubercles prominent and inward curving. Seeds monoembryonic.
Plants of very wet, usually submerged sites.
Chromosome number: 2n=30.
Figure 15.

Small (1933) cited a specimen at NY as the type of this species without explanation of the reasons for his decision. This specimen bears appropriate locality data and also cites "Dr. Loomis." Nuttall's description does not attribute the collection to Loomis, although he is cited as the collector of various other specimens cited in the same publication. Significantly, an additional specimen from this locality housed at AMES (originally at GH) has been annotated by Correll as "doubtless a cotype." This specimen bears the notation "*legit* H.B.

KEY TO NORTH AMERICAN MULTIRANKED *SPIRANTHES*[*]

1: Sepals connate toward base (sometimes only slightly so in S. *lucida*).[**]

2: Lip pandurate, strongly constricted near the middle and dilated toward the base and apex; sepals and petals connivent throughout their lengths and forming a hood (rarely their apices or the lateral sepals free and spreading) .... S. *romanzoffiana*

2: Lip ovate to oblong-quadrate, not pandurate; sepals and petals not connivent throughout their lengths, their apices or the lateral sepals free and spreading.

3: Lip ovate to ovate-lanceolate, tapering toward the apex; flowers yellowish or greenish throughout; far western .... S. *porrifolia*

3: Lip oblong-quadrate; flowers white with lip bright yellow centrally; northeastern and, rarely, central .... S. *lucida*

1: Sepals not connate, free to base.

4: Spike slender, less than 12 mm. in diameter; lip 3–6 mm. long.

5: Lower cauline leaves with well-developed, spreading blades; inflorescence very dense; eastern and central U.S. .... S. *ovalis*

5: Lower cauline leaves reduced to sheathing bracts; inflorescence often an open spiral; Mexico .... S. *graminea*

4: Spike usually stout, 12–35 mm. in diameter; lip more than 6 mm. long.

6: Lip ovate-oblong, fleshy; seeds monoembryonic, the embryo enclosed within the testa.

7: Leaves absent at anthesis; roots tuberous; tubercles of the lip short, conical nobs; lateral sepals spreading and/or ascending .... S. *magnicamporum*

7: Leaves present at anthesis; roots slender; tubercles of the lip relatively long, usually somewhat inward-curving.

8: Lateral sepals usually straight, rather appressed, often connivent with the petals; flowers usually ascending, urceolate; leaves flexible, thin, linear-oblanceolate to narrowly elliptical, basal or a few on the base of the stem; dry or mesic sites in the Northeast (southward along the mountains) .... S. *ochroleuca*

8: Lateral sepals usually curved, loose, spreading and/or ascending, not connivent with the petals; flowers usually nodding, urceolate or often ringent; leaves stiff, thick and aerenchymatous, elliptical to oblong-oblanceolate, extending partially up the stem; swamps and marshes in the Southeast (primarily on the Coastal Plain) .... S. *odorata*

6: Lip usually dilated basally, membranaceous to fleshy, or occasionally undifferentiated from the petals; seeds polyembryonic (at least in part), monoembryonic seeds commonly with extruding embryos .... S. *cernua*

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[*] phyllotaxy of infloresence 1/3 or 1/4 (see text).

[**] Very rare specimens of S. *cernua* from the southern prairie region bear sepals connate at the base. These plants would key to the far-western S. *porrifolia*, from which they differ in their whitish, nodding flowers.

Crown." Although it is possible that all of these specimens were indeed utilized by Nuttall, such a conclusion is purely conjectural. The lack of collector citation on the PH specimen, its place of deposition, and aspects of Nuttall's description which suggest that he had experience with live material, suggest that this specimen is correctly considered as the type.

Gyrostachys triloba and *G. constricta* Small have been variously treated. Ames (1905b) treated both as synonyms of *S. odorata*, stating that the three-lobed nature of the lip of *G. triloba* cited by Small was merely apparent, due to improper spreading of the moistened material. Recently Luer (1975) has treated *G. constricta* as a synonym of *S. cernua*, apparently due to the membranaceous, basally dilated lip of Small's type. Examination of the types of both *G. constricta* and *G. triloba* has shown them to be clearly referable to *S. odorata*. These specimens are poorly preserved, doubtless accounting for their membranaceous and rather dilated lips; vegetatively they are characteristic of *S. odorata* and are, I think, reliably treated as such.

Spiranthes ochroleuca **(Rydberg) Rydberg,** Fl. Prairies 241. 1932.

Basionym: *Gyrostachys ochroleuca* Rydberg in Britton, Man. 300. 1901.
  Ibidium ochroleucum (Rydberg) House, Bull. Torrey Bot. Club 32: 381. 1905.
  Spiranthes cernua (Linnaeus) L. C. Richard var. *ochroleuca* (Rydberg) Ames, Orchid. 1: 145. 1905.
  Triorchis ochroleuca (Rydberg) Nieuwland, Am. Midl. Nat. 3: 123. 1913.
TYPE: Mt. Washington, Mass., 1897. Drawing by Mrs. Long.! (NY).

Erect herb, 10–55 cm. tall, pubescent above, at least some trichomes capitate. Roots few, fasciculate, fleshy, slender, to about 10 cm. long, horizontally spreading. Leaves persistent, few to several, basal, occasionally also on the basal portion of the stem, sessile to short-petiolate, spreading, linear-oblanceolate to narrowly elliptical, flexible, dull, canaliculate, to 2.0 x 21 cm. Inflorescence densely flowered, parastichy low- to high-angled, orthostichies obvious to commonly obscure or seemingly absent, vertical to commonly spiraled. Flowers ivory to yellowish. Perianth urceolate, 6–14 mm. long, the stout, sessile ovary somewhat shorter. Sepals linear-lanceolate, appressed to the petals, the dorsal apically recurved, the lateral straight. Petals linear, associated with the sepals, the apices often recurved. Lip fleshy, oblong to ovate, obtuse to acute, crenulate, recurved-geniculate, basal tubercles prominent and incurved or rarely merely conical. Seeds monoembryonic.
Plants of dry acidic sites.
Chromosome number: 2n=30.
Figure 16a-d.

Rydberg (1901) failed to designate the type of *G. ochroleuca*, and the basis for his description has been unknown. Recently, a comparison of his description with a drawing at NY has indicated that this illustration is Rydberg's type (Sheviak and Catling, 1980).

Spiranthes magnicamporum **Sheviak.** Bot Mus. Leafl. Harvard Univ. 23: 287. 1973.

TYPE: Hill prairie, 3.5 mi., S., of Eldred, Greene Co., Illinois, October 10, 1968, *R. A. Evers 98153!* (ILLS).

Erect herb, 10–60 cm. tall, pubescent above, at least some trichomes capitate. Roots 1–3, rarely more, fasciculate, stout, fleshy, descending, to 8 mm. in diameter and about 10 cm. long. Leaves fugaceous, few, wholly basal, linear-lanceolate to oblanceolate, long-petiolate, membranaceous to rarely somewhat fleshy, lucid, to 1.5 x 16 cm. Inflorescence densely flowered, with the orthostichies prominent, vertical to slightly spiraled. Flowers white to ivory, the lip commonly yellow centrally. Perianth ringent, 5–14 mm. long, the stout, sessile ovary somewhat shorter. Sepals linear-lanceolate, the dorsal appressed to the petals, the lateral spreading and/or ascending, the apex of the dorsal slightly arcuate, the lateral more nearly straight. Petals linear, associated with the dorsal sepal, their apices slightly arcuate. Lip fleshy, ovate to oblong, obtuse to acute, crenulate, arcuate, the apex occasionally reflexed, basal tubercles conical. Seeds monoembyronic.
Plants of calcareous grassland.
Chromosome number: 2n=30.
Figure 16e-h.

Spiranthes cernua **(Linnaeus) L. C. Richard,** Orch. Eur. Annot. 37. 1817.

Basionym: *Ophrys cernua* Linnaeus, Sp. Pl. 2: 946. 1753.
  Limodorum autumnale Walter, Fl. Car. 221. 1788.
  Neottia cernua (Linnaeus) Swartz, Schrad. Neues Journ. Bot. 1: 52. 1805.
  Neottia cernua (Linnaeus) Swartz var. *major* Eaton, Man. 303. 1829.

Spiranthes petiolaris Rafinesque, Herb. Raf. 45. 1833.

Gyrostachys cernua (Linnaeus) Kuntze, Rev. Gen. 2: 664. 1891.

Ibidium cernuum (Linnaeus) House, Bull. Torrey Bot. Club 32: 381. 1905.

Ibidium incurvum Jennings, Ann. Carnegie Mus. 3: 483. 1906.

Triorchis cernua (Linnaeus) Nieuwland, Am. Midl. Nat. 3: 122. 1913.

TYPE: [Virginia, Canada. (Linnaeus, 1753)] Linnaean Herbarium no. 1056.9 (LINN), (photograph!).

Typification of synonyms:

Limodorum autumnale Walter: Walter Herbarium no. 722 (BM), (photograph!).

Neottia cernua var. *major* Eaton: unknown.

Spiranthes petiolaris Rafinesque: apparently destroyed.

Ibidium incurvum Jennings: Pennsylvania, Erie County, in zone around lagoons in eastern part of Presque Isle, sand soil, August 26, 1905, *Otto Jennings 18*! (CM, NY, NYS).

Erect herb, 10–50 cm. tall, pubescent above, with at least some trichomes capitate. Roots few, fasciculate, fleshy, slender, horizontally spreading to stout and descending. Leaves persistent to fugaceous, few, wholly basal or with a few on the lower portion of the stem, linear-lanceolate to linear-oblanceolate or oblanceolate or occasionally obovate or elliptical, membranaceous to rarely slightly fleshy, dull to highly lucid, long- to short-petiolate or occasionally sessile, to 2.0 x 26 cm. Inflorescence densely flowered, with the parastichy low- to rarely very high-angled, the orthostichies obvious to seemingly absent, vertical to spiraled. Flowers white to ivory or rarely yellowish or green, the lip sometimes yellow centrally. Perianth urceolate to ringent or occasionally unopening, 5–12 mm. long, the stout, sessile ovary somewhat shorter. Sepals lanceolate to linear-lanceolate, the dorsal appressed to the petals, the lateral appressed to spreading, the dorsal straight or with the apex recurved, the lateral straight or most commonly with the apices incurved. Petals linear-lanceolate, associated with the dorsal sepal, straight or with the apices recurved; occasionally broad and lip-like, then the apices strongly wide-spreading. Lip membranaceous to fleshy, ovate to oblong in general outline, usually constricted at the middle and with a more or less prominently dilated suborbicular to orbicular base, crenulate, lacerate or sometimes entire, geniculate to arcuate or sometimes straight, basal tubercles prominent and incurved to small and conical; or occasionally lip scarcely or not at all differentiated from petals. Seeds at least in part polyembryonic. Plants of wet to dry situations.
Chromosome number: 2n=(45;) 60 (-62).
Figures 17–23.

Although Linnaeus' brief description of *Ophrys cernua* could apply to *S. ochroleuca* as well as *S. cernua* and in some respects more closely fits the former species, examination of his type clearly has demonstrated that his epithet has been properly applied (Sheviak and Catling, 1980).

Walter's *Limodorum autumnale* is less easily placed. This taxon has typically been treated as a synonym of *S. cernua* (e.g. Ames, 1905b; Luer, 1975). Walter's description, however, with "*caule foliis obsito*" would appear more characteristic of *S. odorata*. Examination of number 722 in Walter's herbarium, the apparent type, does not support such a conclusion. This specimen bears a single leaf, either basal or borne on the base of the stem. In this respect, then, it is more characteristic of *S. cernua* than *S. odorata*, and, indeed, the general aspect of the specimen is that of the former species. Walter's reference to a leafy stem may have been meant in contrast to his *L. praecox*, the specimen of which bears only withered leaves. It thus seems proper to include *L. autumnale* in the synonymy of *S. cernua*.

Eaton's *Neottia cernua* var. *major* cannot be placed with absolute certainty from his scanty description. Very likely, however, it is referable to a particularly robust, large-flowered race of *S. cernua* which is abundant in the northeast (Figure 19a-d). Certainly *S. cernua* is among the largest species in the area and it would appear unlikely that Eaton's name is based on another species.

Rafinesque's description of *S. petiolaris* is clearly referable to *S. cernua*. The description closely fits an important race of *S. cernua* from the prairie margin and Southeast [the "old field ecotype" of Sheviak, (1974b); Figure 20e-h] and considering the Illinois origin of Rafinesque's plant, such an identity is a distinct possibility.

Ibidium incurvum Jennings was separated from *S. cernua* primarily on the basis of the long, incurved tubercles of Jennings' type material. Later, Jennings (1953) recognized the variable nature of this character in *S. cernua* and stated that *I. incurvum* is characteristic of northeastern, arenicolous *S. cernua*. Furthermore, live material from the type locality has proven to be typical *S. cernua* and also identical with Jennings' material of *I. incurvum* (Sheviak and Catling, 1980).

Nomina Obscura

Spiranthes brevicaulis **Rafinesque,** Herb. Raf. 45. 1833.

This taxon would appear to be part of the S. *cernua* complex on the basis of, "*fl. magnis curvis,*" and the origin having been Kentucky. Rafinesque's description is difficult to interpret, however. This is particularly true of, "*fol. rad. conica longissima lineari cuneati acuta.*" I cannot with certainty ascribe such leaves to any plant known to me. However, in some members of the prairie complex, commonly the very base of the stem immediately above the withering leaves bears a number of bracts with elongated, divergent apices. These structures have the blade rolled to form a tube that might be described as conical. This is typical of one important form (Figure 21a-d), small plants of which sometimes produce open, rather obviously spiralled inflorescences. It is thus significant that Rafinesque described the spike of this "semipedal" plant as "*spicis flexuosis obl. laxis paucifl.*" Such analysis is purely conjectural, however, and the name cannot be placed.

Spiranthes flexuosa **Rafinesque,** Herb. Raf. 45. 1833.
Spiranthes montana **Rafinesque,** Herb. Raf. 45. 1833.

These two taxa are included here on the basis of "*spicis densis spir.*" The flowers of both are described as "*mediocris.*" These features suggest one of the smaller flowered forms of S. *cernua.* Fernald (1946a) referred S. *montana* to S. *ovalis,* but this is purely conjectural; it is doubtful that the very small flowers of S. *ovalis* would warrant the use of "*mediocris.*" These names cannot be placed.

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TABLE I

Literature Reports of Chromosome Numbers of North American *Spiranthes* (Numbers reported for *S. cernua* complex members by Sheviak (1976) and Sheviak & Catling (1980) are included in Table II).

species	locality	somatic	sporogenous	reference
S. casei var. *casei*				
	Muskoka Dist., Ontario	*ca.* 60–70		Catling (1980)
	Muskoka Dist., Ontario	*ca.* 65–75		Catling (1980)
S. cernua				
	Shefford Co., Quebec	45±3		Catling (1980)
	Berkshire Co., Massachusetts		n=30±2	Catling (1980)
	Bristol Co., Massachusetts		n=30±2	Catling (1980)
	Chicago, Illinois	*ca.* 60	n=30	Pace (1914)
	Douglas Co., Kansas	*ca.* 50		Smith (1964)
	North America	30		Tanaka (1965, 1969)
S. lacera				
	Chicago, Illinois	30	n=15	Pace (1914)
	Massac Co., Illinois	30		Sheviak (1976)
S. lacera var. *lacera*				
	Perry Sound Dist., Ontario		n=15	Catling (1980)
	Simcoe Co., Ontario	30	n=15	Catling (1980)
	York Co., Ontario		n=15	Catling (1980)
S. lucida				
	Bruce Co., Ontario		n=22±2	Catling (1980)
	Ontario Co., Ontario		n=22±2	Catling (1980)
S. magnicamporum				
	Kent Co., Ontario		n=15	Catling (1980)
S. ochroleuca				
	Berkshire Co., Massachusetts		n=15	Catling (1980)
S. romanzoffiana				
	Hastings Co., Ontario		n=22±1	Catling (1980)
	Northumberland Co., Ontario		n=22±1	Catling (1980)
	Perry Sound Dist., Ontario		n=22	Catling (1980)
	Somerset Co., Maine		n=22	Catling (1980)
	Queen Charlotte Islands, B.C.		$2n=15_{II}$	Taylor & Mulligan (1968)
	Northern Ireland	60		Heslop-Harrison in Löve & Löve (1961)
S. vernalis				
	Ocean Co., New Jersey		n=15	Catling (1980)
	Harris Co., Texas		$2n=15_{II}$	Sheviak (1976)

TABLE II

Chromosome Number Determinations

species/locality/collection	somatic	sporogenous
S. odorata		
FLORIDA		
Collier Co. (*Sheviak 817)*	30	
Manatee Co. (*Sheviak 814*)	30	
Sarasota Co. (*Sheviak 810*)	30	
GEORGIA		
Chattam Co. (*Barnes s.n. "b")*	30	
KENTUCKY		
Woodford Co. (*Sheviak & Medley 2159*)	30	15_{II}
NORTH CAROLINA		
Brunswick Co. (*Sheviak 2188c*)	30	
S. ochroleuca		
KENTUCKY		
Powell Co. (*Sheviak 2158b*)	30	
MAINE		
Sagadahoc Co. (*Sheviak 870)*	30	
Sagadahoc Co. (*Sheviak 915)*	30	
MASSACHUSETTS		
Berkshire Co. (*Catling 831c*)	30*	
Berkshire Co. (*Sheviak & Hart 1076*)	30	
MICHIGAN		
Saginaw Co. (*Case s.n.*)	30	
Saginaw Co. (*Sheviak 1065*)	30	
NEW HAMPSHIRE		
Belknap Co. (*Sheviak & Sheviak 1022*)	30	
Cheshire Co. (*Sheviak & Sheviak 1041*)	30	15_{II}
Coös Co. (*Catling* 1 Sept. 76)	30	15_{II}
Sullivan Co. (*Sheviak 877)*	30	
S. magnicamporum		
ILLINOIS		
Cass Co. (*Sheviak & Shildneck 2142b*)	30	15_{II}
Greene Co. (*Evers s.n.*)	30	
Greene Co. (*Sheviak 352*)	30	
Greene Co. (*Sheviak 989*)	29–31	
Lake Co. (*Sheviak 708*)	30	

TABLE II: Chromosome Number Determinations (cont'd)

species/locality/collection	somatic	sporogenous
S. magnicamporum (cont'd)		
KANSAS		
Franklin Co. (*Sheviak & Sheviak 960*)	30	15_{II}
Marshall Co. (*Sheviak & Niemann 944*)	30	
NEW MEXICO		
Bernalillo Co. (*Todsen 49141*)	30	
OKLAHOMA		
Carter Co. (*Magrath 8672b*)	30	
Comanche Co. (*Magrath 8665a*)	30	
Comanche Co. (*Magrath 8665b*)	30	
Comanche Co. (*Magrath 8665c*)	30	
Comanche Co. (*Magrath 8665L*)	30	
S. cernua		
ILLINOIS		
Bond Co. (*Sheviak & Sheviak 981b*)	60	
Bond Co. (*Shildneck C-7823/2*)	60	
Bond Co. (*Shildneck C-7823/7*)	*ca.* 60	
Bond Co. (*Shildneck C-7823/8*)	60	
Bond Co. (*Shildneck C-7823/10*)	60	
Bond Co. (*Shildneck C-7823/11*)	60	
Bond Co. (*Shildneck C-7823/13*)	62	
Bond Co. (*Shildneck C-7823/14*)	62	
Coles Co. (*Sheviak 388b*)	61	30_{II}, 1_{I}
Cook Co. (*Sheviak 520*)	45	
Dekalb Co. (*Sheviak et al. 1314*)	45	
Fayette Co. (*Shildneck CC/A*)	*ca.* 60	
Fayette Co. (*Shildneck CC/X*)	*ca.* 60	
Iroquois Co. (*Sheviak 699*)	60	
Kankakee Co. (*Sheviak & Niemann 900a*)	*ca.* 60	
LaSalle Co. (*Sheviak 363*)	45	
Macon Co. (*Sheviak 691*)	60	
Pope Co. (*Sheviak 706*)	60	
Pope Co. (*Sheviak 707*)	60	
Vermillion Co. (*Sheviak 703*)	60	
Will Co. (*Sheviak 470*)	60	
IOWA		
Boone Co. (*Sheviak 869a*)	60	
Boone Co. (*Sheviak 869b*)	*ca.* 60	
Decatur Co. (*Sheviak & Niemann 929*)	45	

TABLE II: Chromosome Number Determinations (cont'd)

species/locality/collection	somatic	sporogenous
S. cernua (cont'd)		
KANSAS		
Bourbon Co. (*Sheviak & Sheviak 975a*)	*ca.* 60	
Franklin Co. (*Sheviak & Sheviak 962*)	60	
Osage Co. (*Sheviak & Niemann 954*)	60	
MAINE		
York Co. (*Sheviak & Sheviak 1113*)	45	
MASSACHUSETTS		
Berkshire Co. (*Catling 83a*)	*ca.* 60*	
Middlesex Co. (*Sheviak 821*)	*ca.* 60	
Worcester Co. (*Sheviak 891*)	60	
Worcester Co. (*Sheviak 922*)	60	
NEBRASKA		
Sarpy Co. (*Sheviak & Niemann 939a*)	60	
NEW HAMPSHIRE		
Merrimack Co. (*Sheviak 875*)	60	
Sullivan Co. (*Sheviak 1063*)	45	
Sullivan Co. (*Sheviak & Sheviak 1036b*)	61	
Sullivan Co. (*Sheviak & Sheviak 1034*)	45	
NEW YORK		
Hamilton Co. (*Sheviak 1654*)	*ca.* 60	
Hamilton Co. (*Sheviak 1926*)	45	

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* Counted by P.M. Catling

TABLE III

Results of Experimental Crosses

Parental plants are indicated by the author's collection number (or other collector) and the collection locality. Capsule development for each flower is indicated as an approximate percentage of the volume of normal capsules resulting from intraspecific crosses; in some early crosses capsule development was not noted. Fertility of the total sample of each cross is indicated as a percentage of normal seed set resulting from intraspecific crosses, based on an average figure of 10,000 seeds per capsule. *In one cross, capsules did not dehisce.

cross	no. flowers used	capsule development	seeds	% fertility
S. odorata (814; Manatee Co., Florida)				
X *S. ochroleuca* (715; Cheshire Co., N.H.)	3	1 abort, 2–50%	0	0
X *S. ochroleuca* (915; Sagadahoc Co., Maine)	3	3–50%	8	0.0003
X *S. magnicamporum* (362b; Lake Co., Illinois)	4	2 abort, 1–75%, 1–100%	0	0
S. ochroleuca (715; Cheshire Co., N.H.)				
X *S. odorata* (814; Manatee Co., Florida)	3	2 abort, 1–50%	0	0
X *S. magnicamporum* (362b; Lake Co., Illinois)	3	1 abort, 2–100%	25	0.0008
X *S. cernua* (891; Worcester Co., Mass.)	3	3 abort	0	0
S. ochroleuca (877; Sullivan Co., N.H.)				
X *S. odorata* (814; Manatee Co., Florida)	2	1 abort, 1–25%	4	0.0002
X *S. magnicamporum* (362b; Lake Co., Illinois)	3	3–25%	*ca.* 300	0.01
S. ochroleuca (915; Sagadahoc Co., Maine)				
X *S. magnicamporum* (362b; Lake Co., Illinois)	5	1 abort, 4–25%	4	0.00008
S. magnicamporum (362b; Lake Co., Illinois)				
X *S. odorata* (814; Manatee Co., Florida)	4	1 abort, 3–75%	*ca.* 20,000	50
X *S. ochroleuca* (915; Sagadahoc Co., Maine)	4	1 abort, 3–30%	10	0.0003
X *S. cernua* (470; Will Co., Illinois)	3	3–25% *	22	0.0007
X *S. cernua* (256; Will Co., Illinois)	3	n.d.	0	0
X *S. cernua* (275; Pope Co., Illinois)	2	n.d.	0	0
X *S. cernua* (276; Fountain Co., Indiana)	2	n.d.	0	0
S. magnicamporum (350; Greene Co., Illinois-3 plants)				
X *S. cernua* (256; Will Co., Illinois)	5	n.d.	0	0
X *S. cernua* (275; Pope Co., Illinois)	4	n.d.	0	0
X *S. cernua* (276; Fountain Co., Indiana)	4	n.d.	0	0
S. magnicamporum (*McCabe s.n.*; Clay Co., Minnesota)				
X *S. odorata* (814; Manatee Co., Florida)	5	3 abort, 2–33%	38	0.0008

TABLE IV

Spiranthes pollinator records

species/pollinator	locality	*Spiranthes* coll. #/notes/reference
S. odorata		
Bombus americanorum	Florida	Dodson (pers. comm.)
B. impatiens	Massachusetts	*Sheviak 814, 816/ greenhouse*
S. ochroleuca		
Bombus impatiens	Massachusetts	*Sheviak 712/* greenhouse
B. vagans	Vermont	*Sheviak 1057*
S. magnicamporum		
Bombus fervidus	North Dakota	*Sheviak & Sheviak 1302*
S. cernua		
Bombus fervidus	New Hampshire	Luer (1975)
B. fervidus	Vermont	*Sheviak 1059*
B. fervidus	New York	*Sheviak 1928*
B. fervidus	New York	*Sheviak 1958*
B. impatiens	Massachusetts	*Sheviak 256, 276, 702, 821, 891/* greenhouse
B. terricola	New York	*Sheviak 1644*
B. terricola	New York	*Sheviak & Sheviak 1956*
B. terricola	Kansas	*Sheviak & Sheviak 972*
Bombus sp.	New York	*Sheviak & Paulson 1667*
Bombus sp.	Nebraska	*Sheviak & Niemann 939*
S. romanzoffiana		
Bombus sp.	Northern Ireland	Godfery (1931, 1933)
Halictus sp.	Northern Ireland	Godfery (1933)
Chlorhalictus sp.	Northern Ireland	Godfery (1933)
S. casei		
Bombus terricola	New York	*Sheviak & Sheviak 1954*
S. lacera		
Bombus americanorum	Illinois	Robertson (1893, 1928)
Calliopsis andreniformis	Illinois	Robertson (1893, 1928)
Anthidium notatum	Florida	Robertson (1893)
Megachile brevis	Florida	Robertson (1893)
S. spiralis		
"humble bees"	England	Darwin (1877)
S. sinensis		
Coelioxys albolineata	Australia	Coleman (1934)
Halictus sp.	Australia	Coleman (1934)
Apis mellifera	Australia	Coleman (1934)

FIGURES

FIGURE 1: Mitotic Metaphase: Diploids
a: *Spiranthes odorata: Sheviak 810,* Sarasota County, Florida. 2n=30.

b: *Spiranthes ochroleuca: Sheviak & Hart 1076a',* Berkshire County, Massachusetts. 2n=30.

c: *Spiranthes magnicamporum: Sheviak & Shildneck 2142b,* Cass County, Illinois. 2n=30.

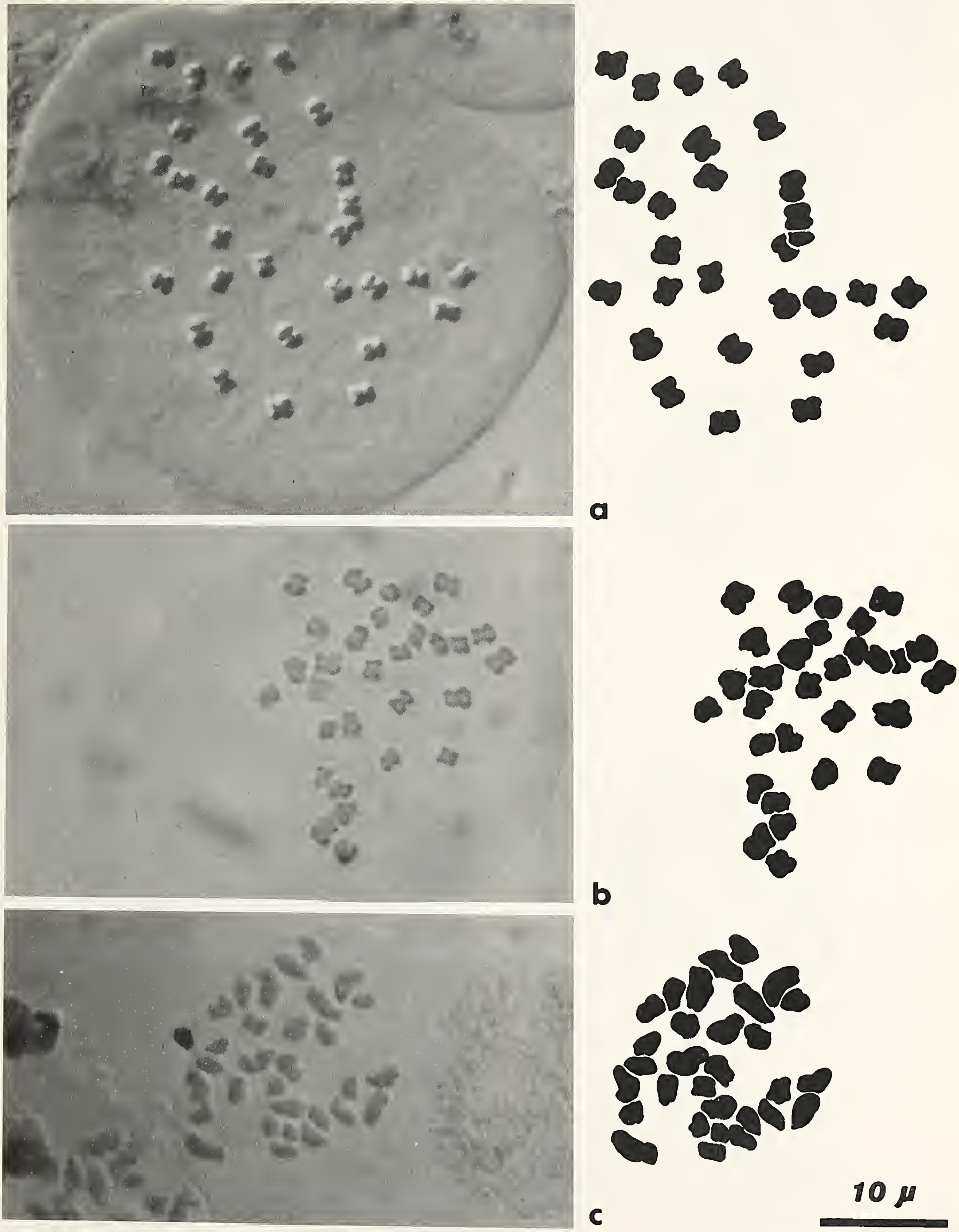
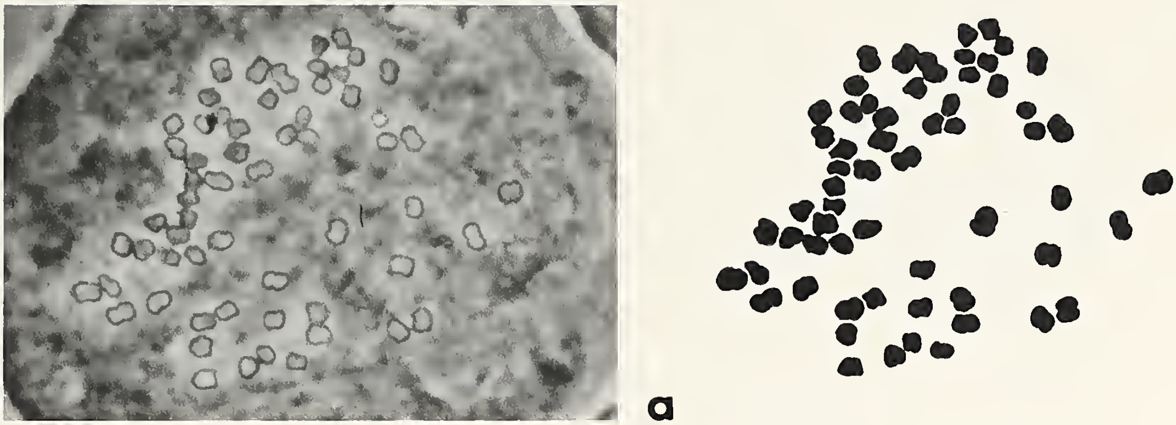

a
b
c
10 µ

FIGURE 2: Mitotic Metaphase: Polyploids
a: *Sheviak 891,* Worcester County, Massachusetts. 2n=60.
b: *Sheviak 691,* Macon County, Illinois. 2n=60.
c: *Sheviak 703,* Vermilion County, Illinois. 2n=60.



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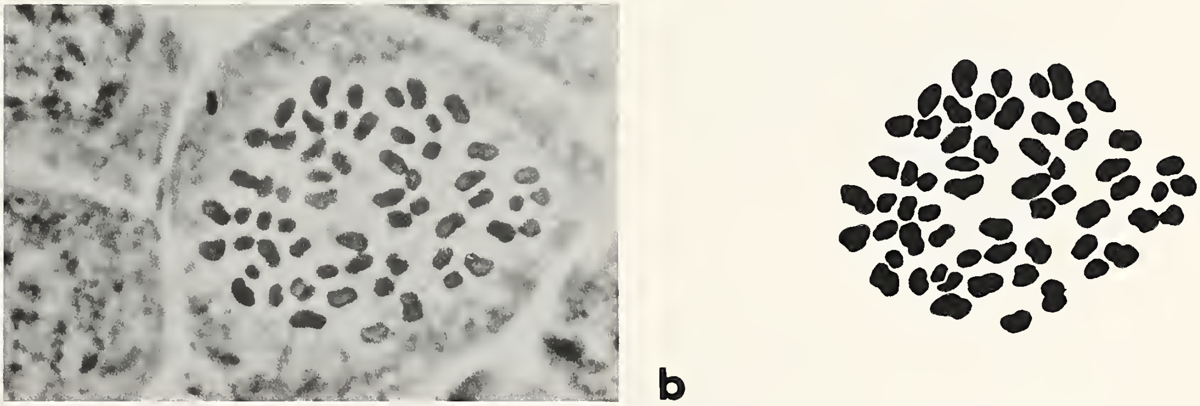

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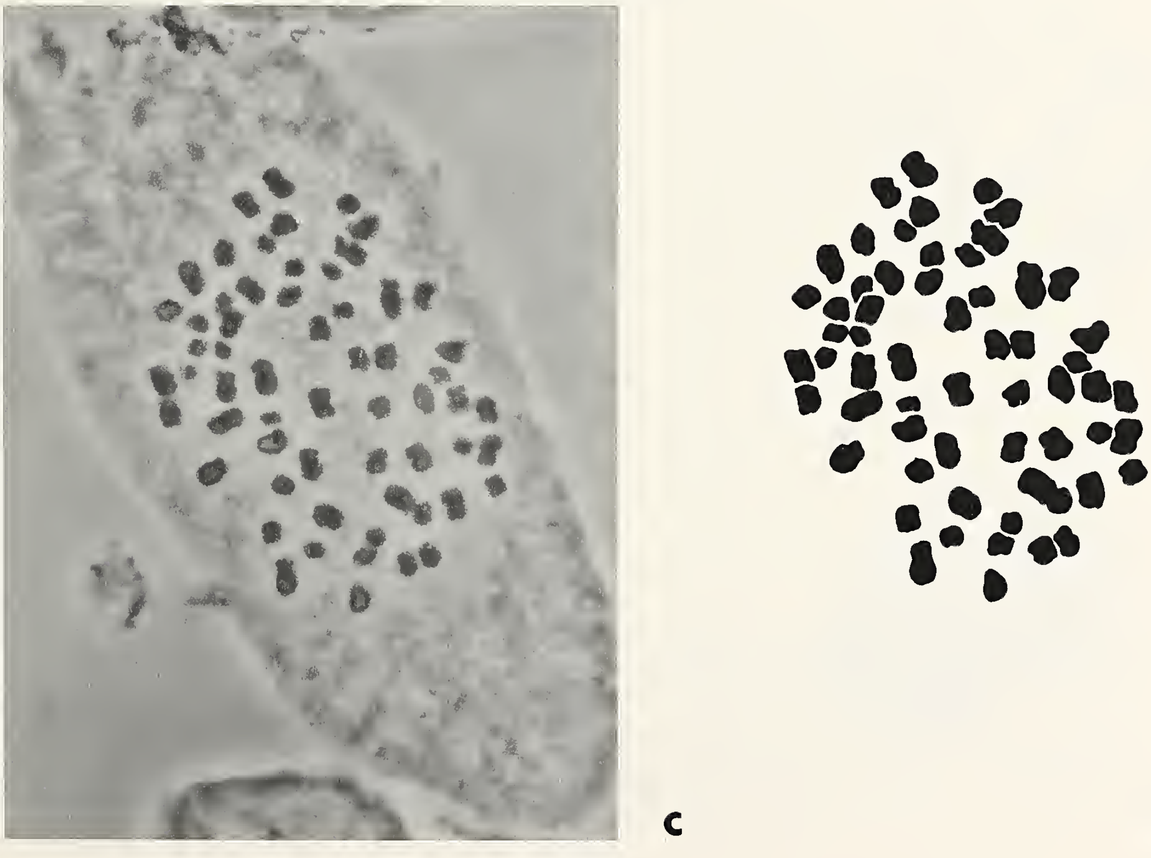
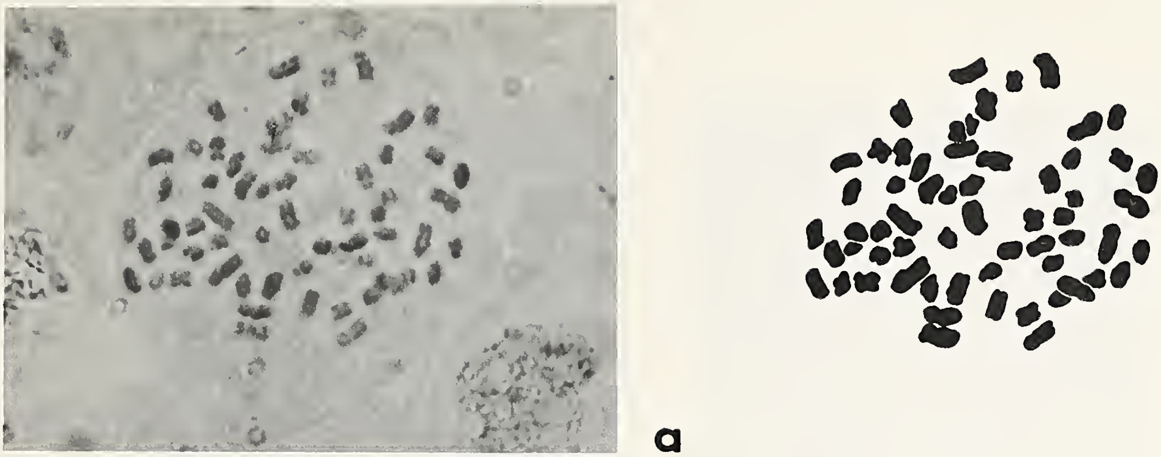


c

10 μ

FIGURE 3: Mitotic Metaphase: Polyploids
a: *Sheviak & Niemann 954*, Osage County, Kansas. 2n=60.
b: *Sheviak 388b*, Coles County, Illinois. 2n=61.
c: *Sheviak 1926*, Hamilton County, New York. 2n=45.
d: *Sheviak et al. 1314*, Dekalb County, Illinois. 2n=45.



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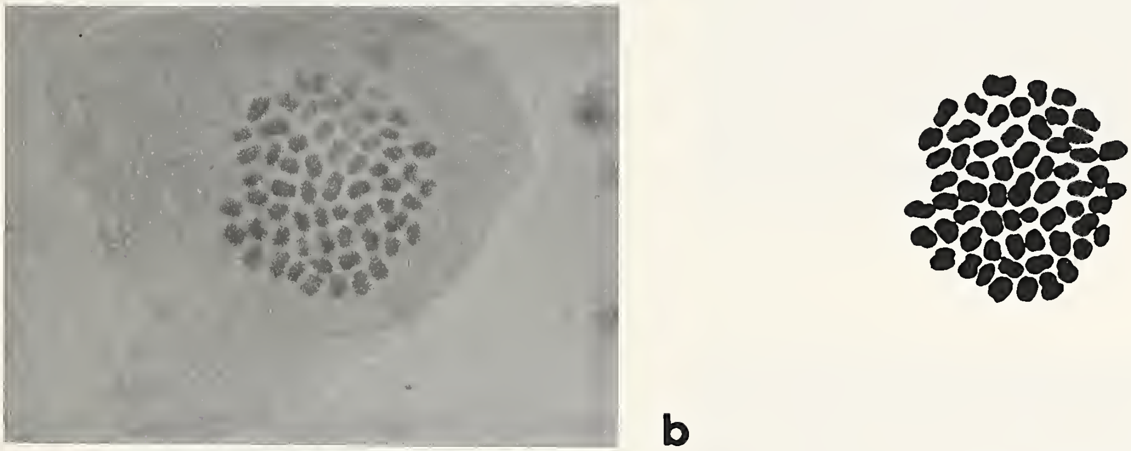

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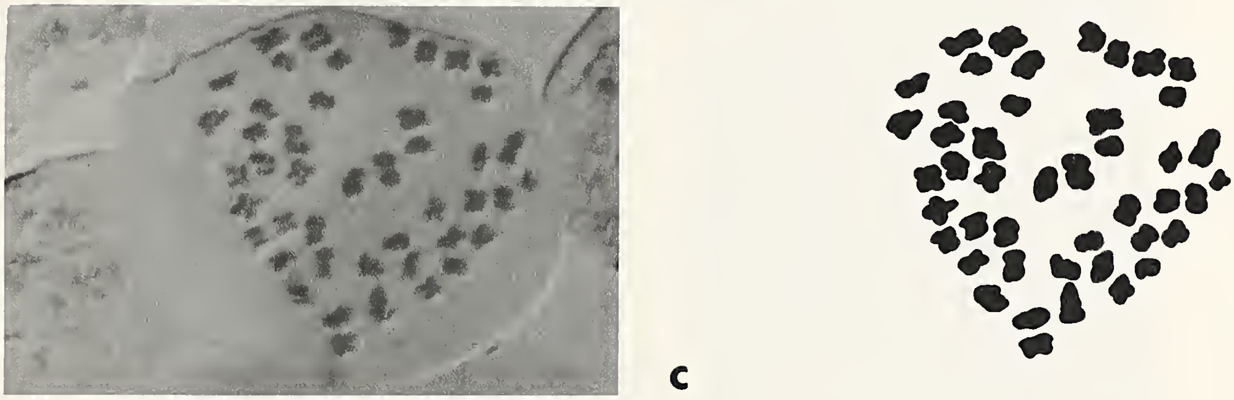

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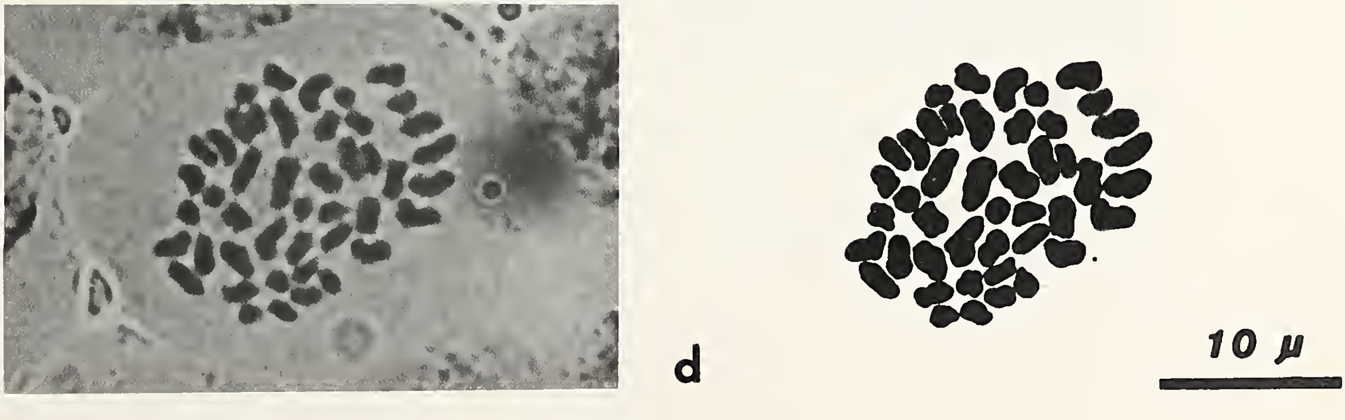


d

FIGURE 4: Meiosis

a-b: Complex pairing at Metaphase I in *Spiranthes cernua* (2n=60): *Sheviak & Sheviak 962*, Franklin County, Kansas.

c-d: Bridges and lagging chromosomes at Anaphase I in *Spiranthes cernua* (2n=60): *Shildneck C-7823/8*, Bond County, Illinois.

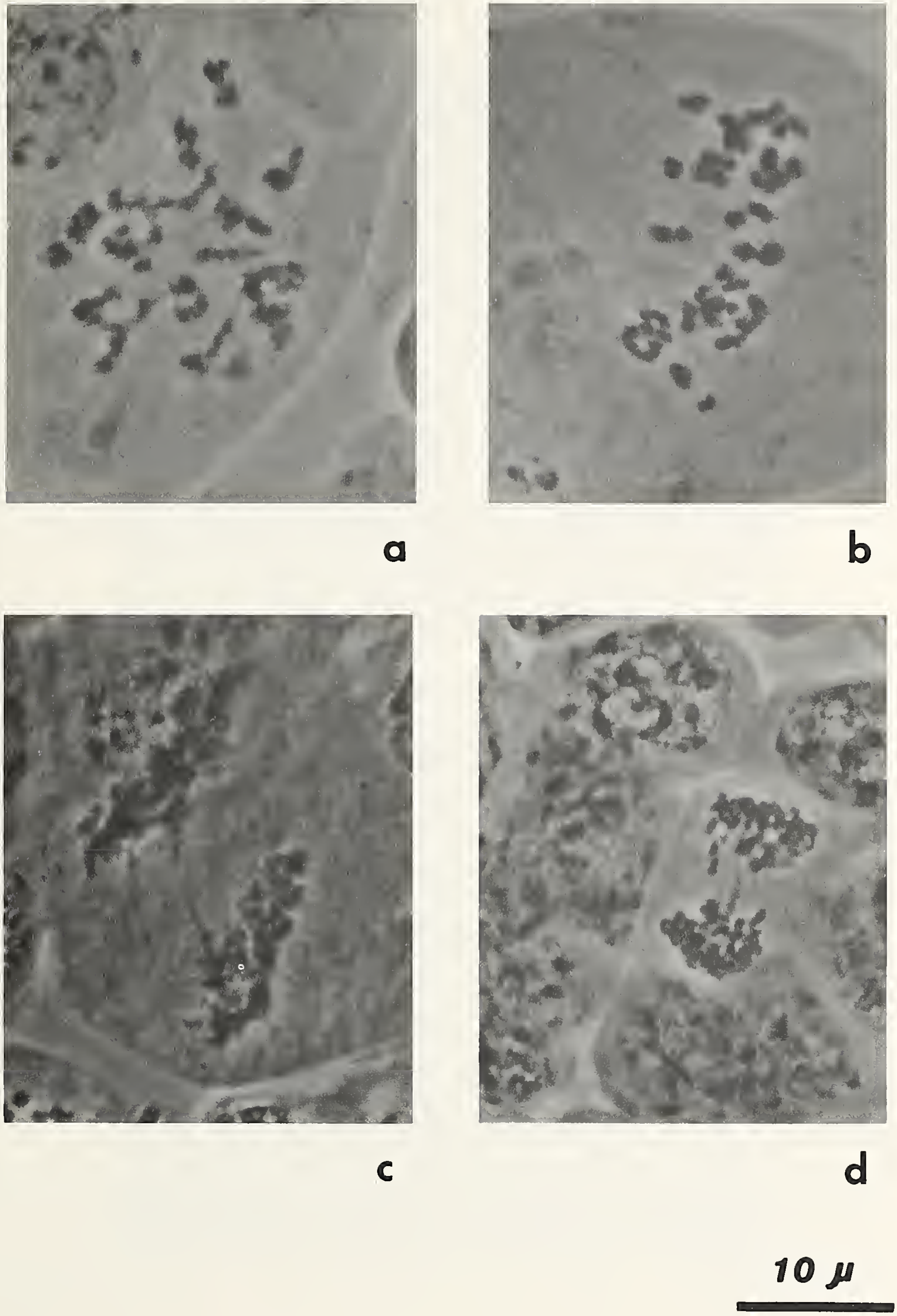
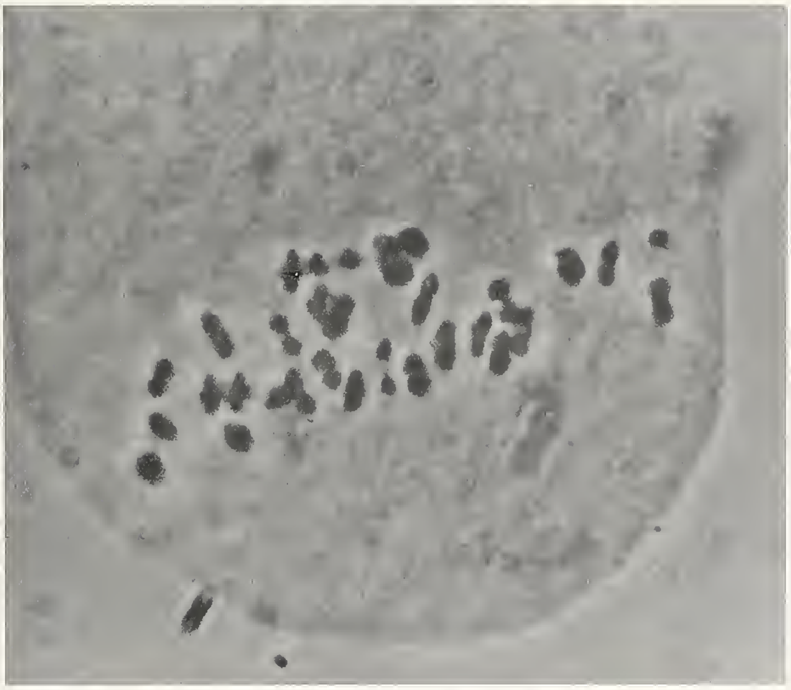

a
b
c
d
10 µ

FIGURE 5: Meiosis

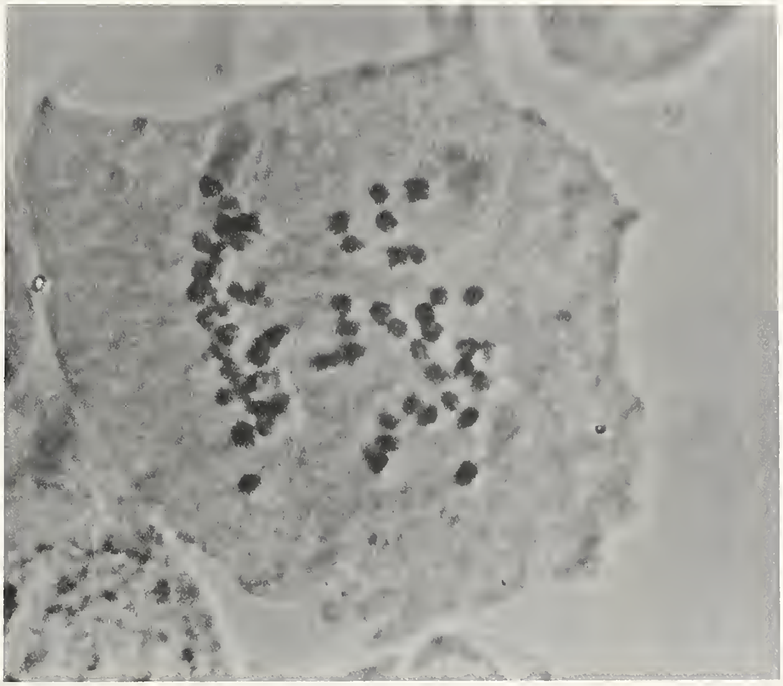
Regular pairing and segregation in *Spiranthes cernua* (2n=61): *Sheviak 388b,* Coles County, Illinois.

a: Perfect pairing (30_{II} 1_{I}) at Metaphase I.

b: Perfect segregation at Anaphase I, with 30 chromosomes to the right, plus one lagging slightly and out of the plane of focus.

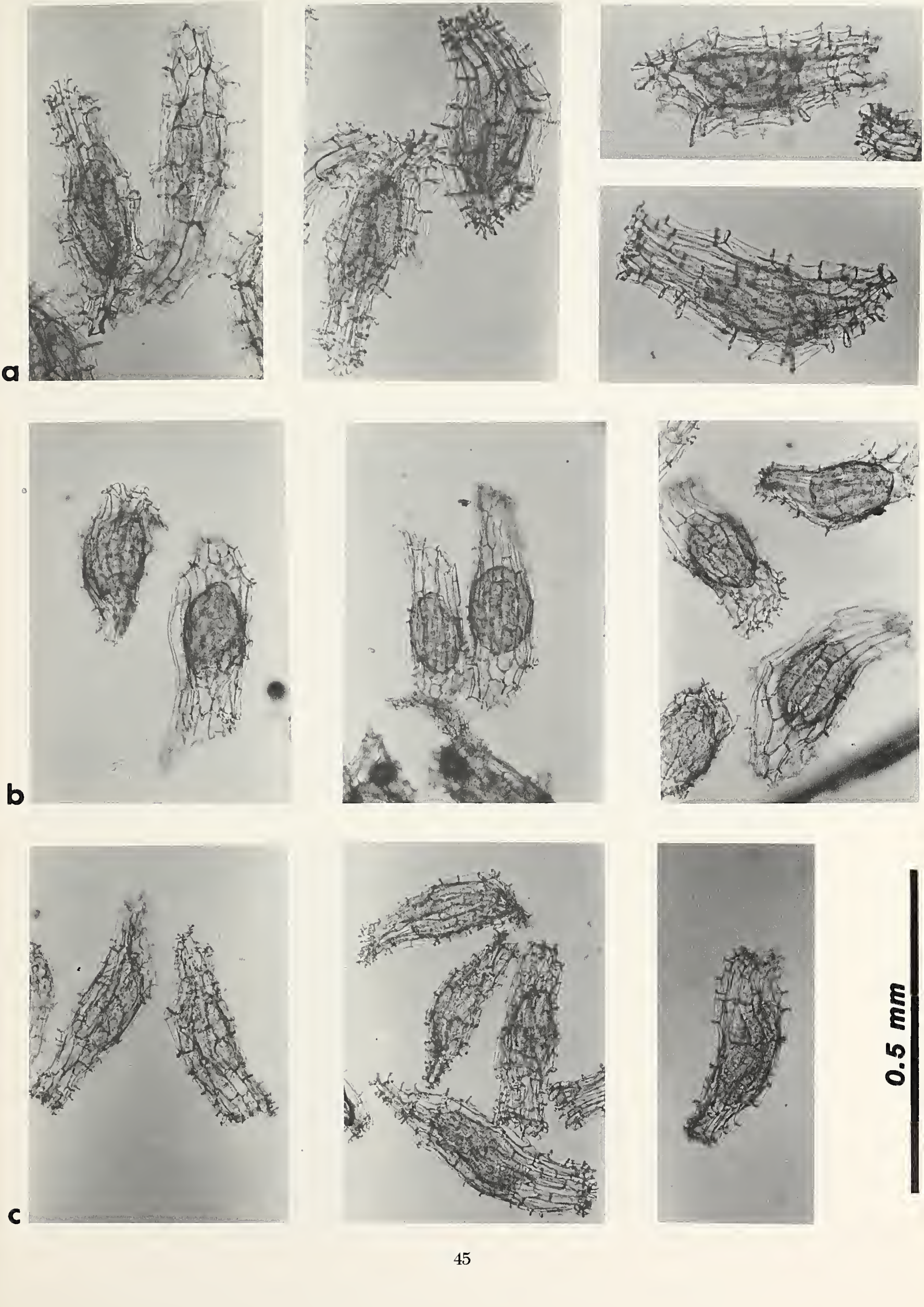


a



b

FIGURE 6: Seeds: Diploids
a: *Spiranthes odorata: Sheviak 810,* Sarasota County, Florida.
b: *Spiranthes ochroleuca: Sheviak 712,* Sagadahoc County, Maine.
c: *Spiranthes magnicamporum: Sheviak 352,* Greene County, Illinois.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0.5 mm

FIGURE 7: Seeds: Polyploids

a: *Sheviak 1051*, Addison County, Vermont. Seed with two embryos, one wholly internal, the other partially extruding.

b: *Sheviak 707*, Pope County, Illinois. Three monoembryonic seeds, two with wholly internal embryos (appearing "normal"), and the third with the embryo partially extruding.

c: *Sheviak 707*, Pope County, Illinois. Two seeds, one without embryo and sterile, and the other with two internally developed embryos.

d: *Sheviak 707*, Pope County, Illinois. Seed with three internally developed embryos.

e: *Sheviak 363*, La Salle County, Illinois. Two monoembryonic seeds with internally developed embryos and appearing "normal."

f: *Sheviak 363*, La Salle County, Illinois. Three seeds, two without embryos and sterile, and the other with one large and possibly two small embryos developed externally.

g: *Sheviak 363*, La Salle County, Illinois. Seed with two externally developed embryos and a small, necrotic, internal one.

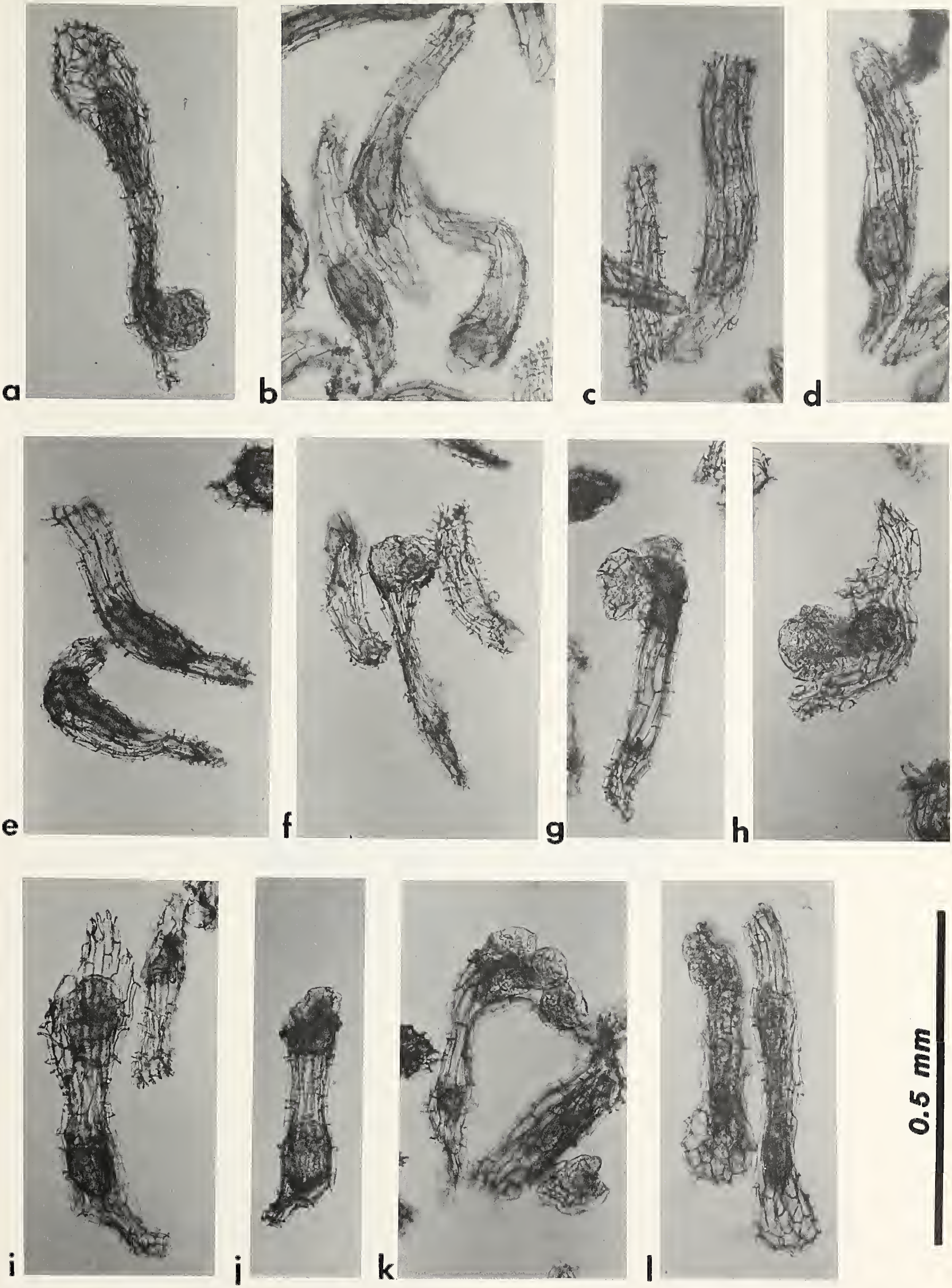
h: *Sheviak 363*, La Salle County, Illinois. Seed with laterally extruding embryo, and an apparently distinct, second, internal embryo.

i: *Sheviak 363*, La Salle County, Illinois. Two seeds, one with small, probably necrotic embryo, the other with two internal embryos.

j: *Sheviak 363*, La Salle County, Illinois. Seed with two embryos, one internal, the other partially extruding.

k: *Sheviak 363*, La Salle County, Illinois. Two seeds, one with small, necrotic, internal embryo, and four embryos developed externally, and the other with ill-defined internal development and a single externally developed embryo.

l: *Sheviak 892*, Middlesex County, Massachusetts. Two seeds with narrow embryonic masses filling much of the interior of the seed; embyro number is unclear, but note the extruding portion in the left-hand seed.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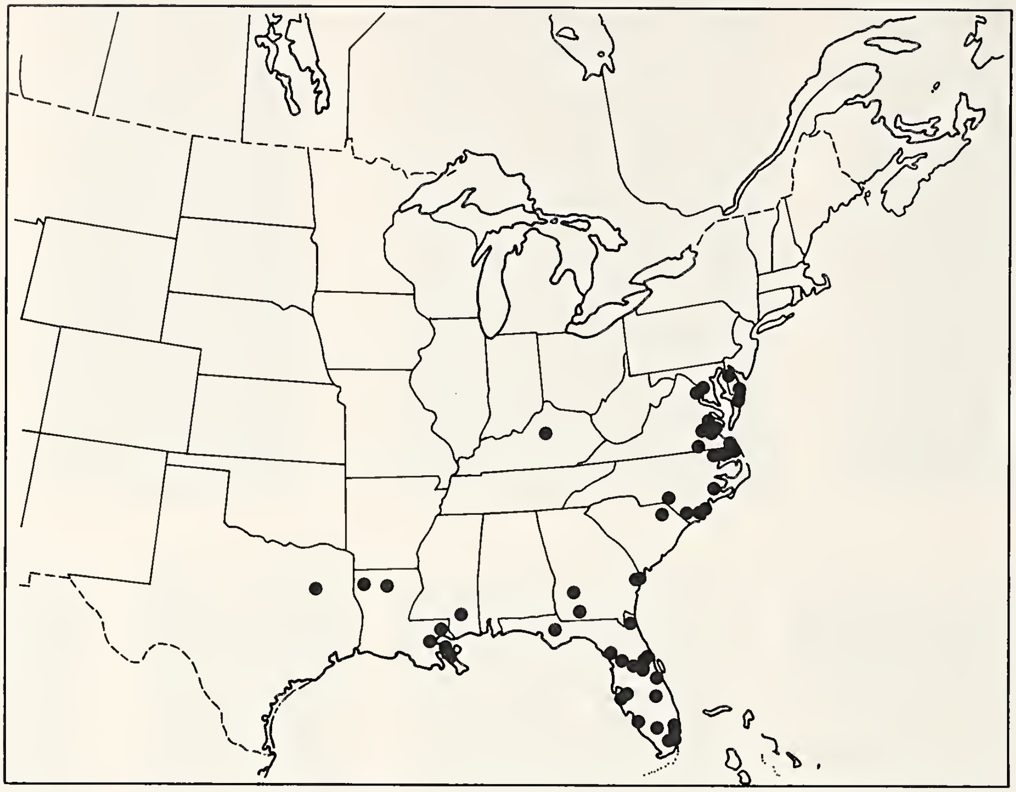


FIGURE 8: Distribution of *S. odorata.*

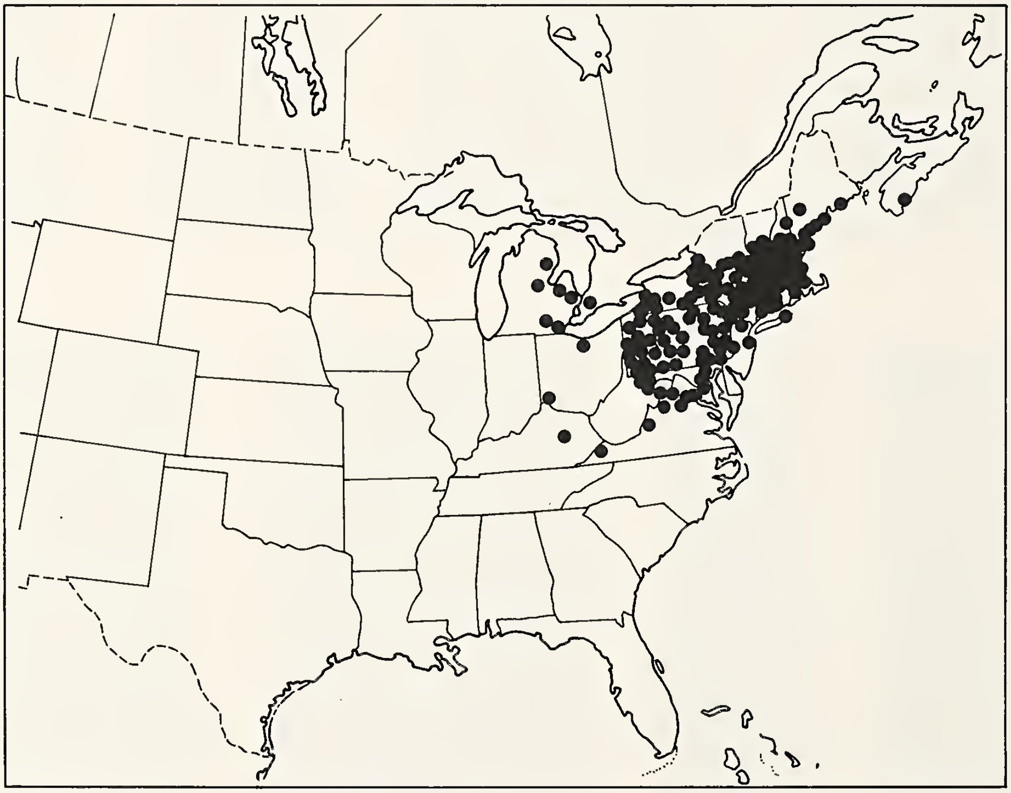


FIGURE 9: Distribution of *S. ochroleuca.* [A few collections plotted in Sheviak & Catling (1980), but not seen by the present author, are omitted from this map.]

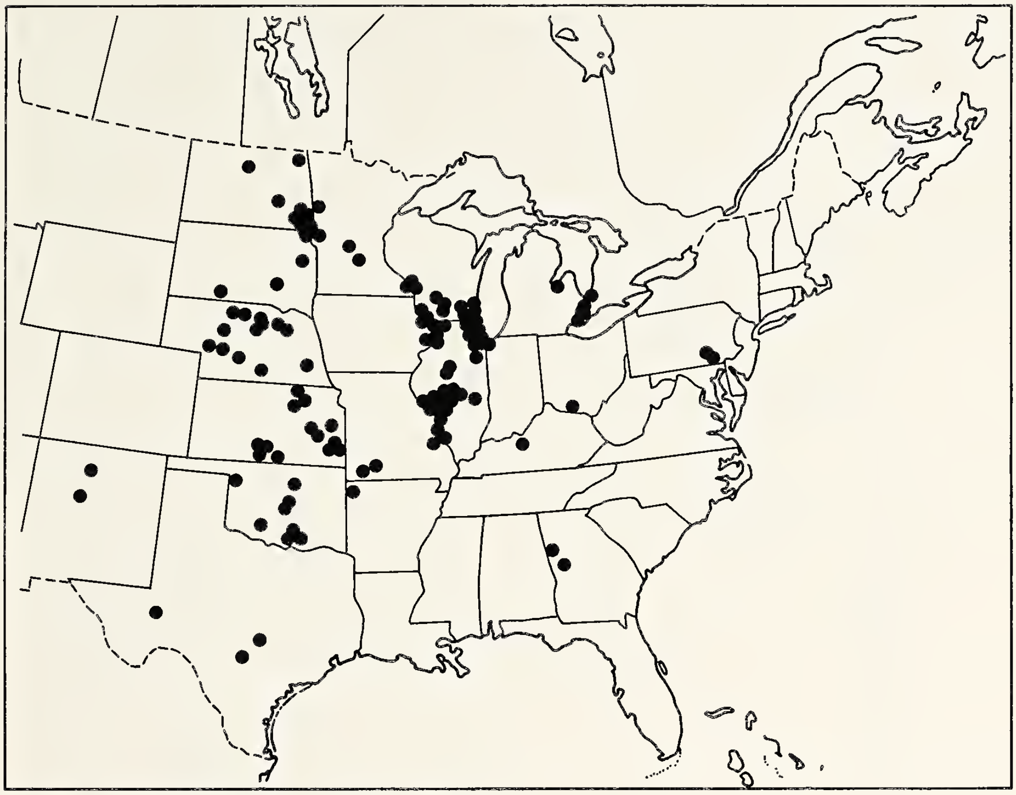


FIGURE 10: Distribution of S. *magnicamporum.*

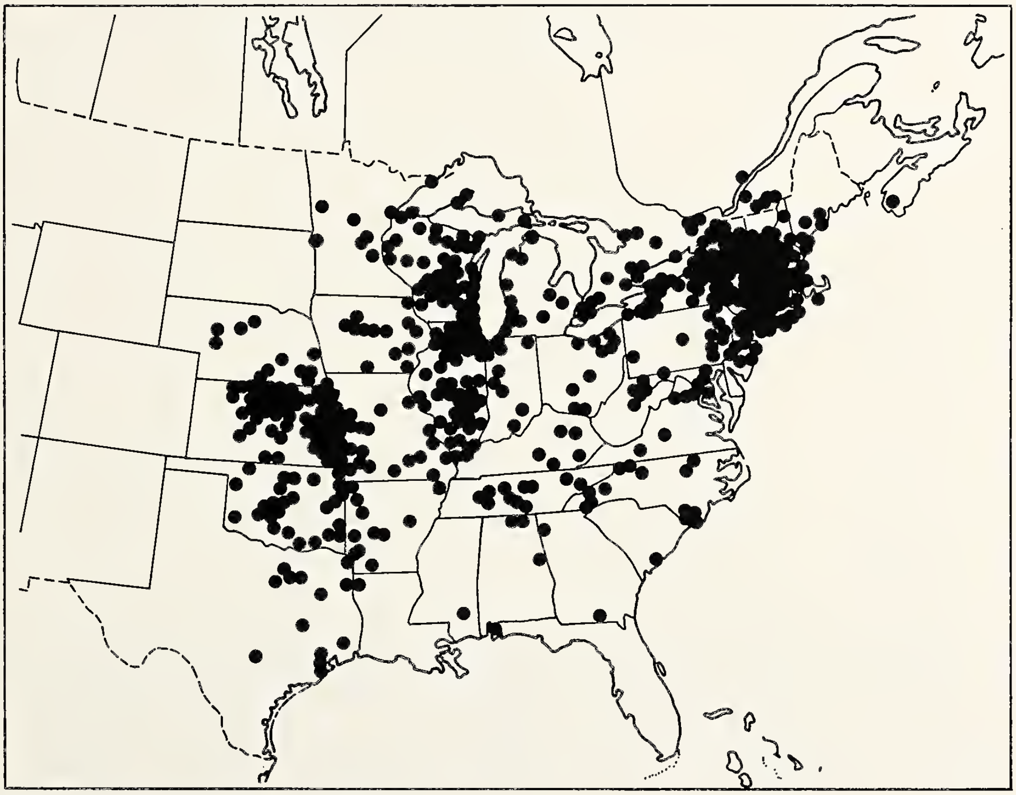


FIGURE 11: Distribution of S. *cernua.*

FIGURE 12: The pattern of combinations of character states in important members of the *S. cernua* complex in the Northeast and Midwest. Three lip characters are plotted as functions of leaf persistence, petiole development, root orientation, and tuberosity. The positions of *S. ochroleuca*, *S. magnicamporum*, and "typical" *S. cernua* (as illustrated in Figure 17a) are indicated. Positions of the plots within the grid squares is based on relative expression of the characters plotted and additional characters. Numbers are diploid chromosome numbers.

KEY

lip

- ▽ dilated, membranaceous
- ▽ dilated, fleshy
- ○ ovate, membranaceous
- ● ovate, fleshy
- ▮ signifies yellowish coloration

roots

- tuberous, descending
- tuberous, horizontal
- slender, horizontal

leaves

- long-petiolate, fugaceous
- long-petiolate, persistent
- short-petiolate, persistent

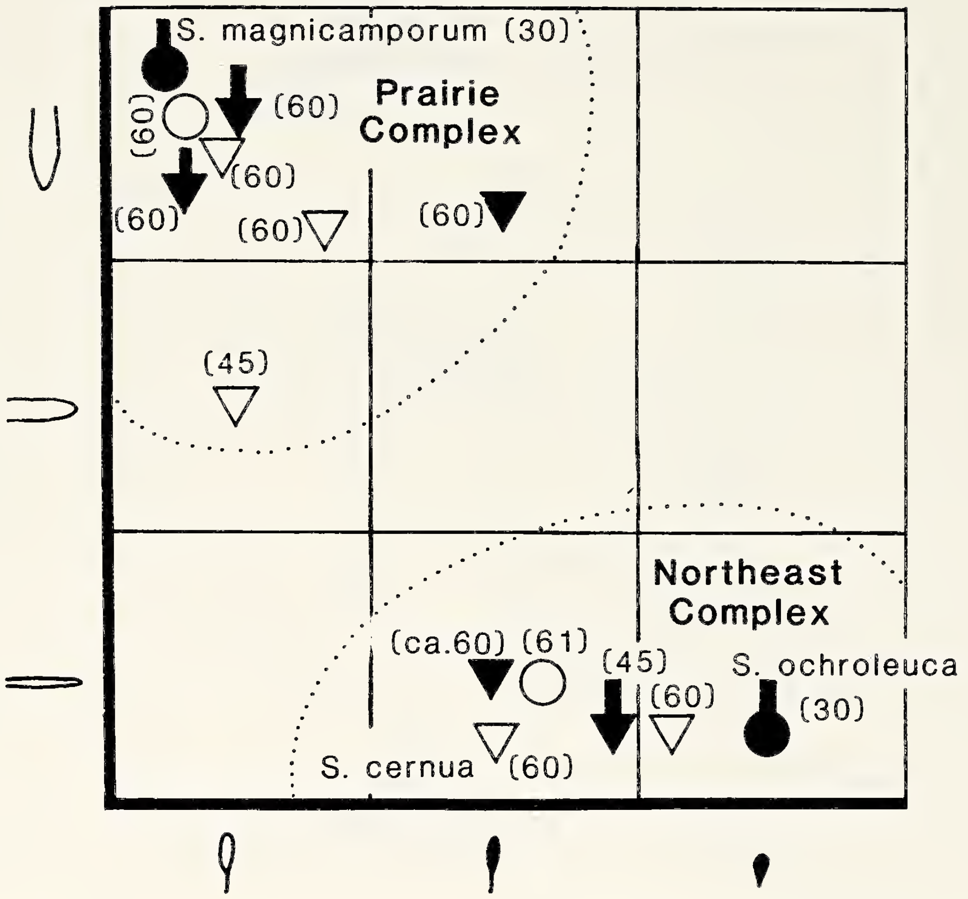
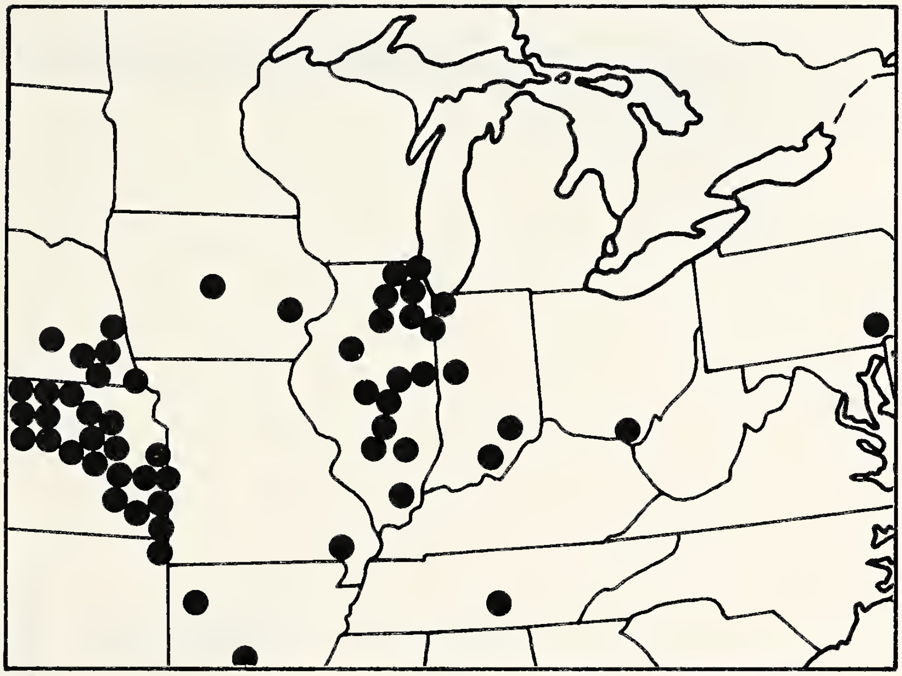


FIGURE 13: Distribution of polyploids exhibiting two prairie complex morphologies. Compare these maps with the distribution of S. *magnicamporum* (Figure 10).

a: Tuberous roots (defined as thickness in excess of 4 mm.), based on herbarium specimens and field observations. Root tuberosity is general in the western portion of the region, but roots are too infrequently collected to provide a one-to-one correlation with the distribution map for S. *cernua* (Figure 11).

b: Peloria (lip an essentially unmodified third petal).



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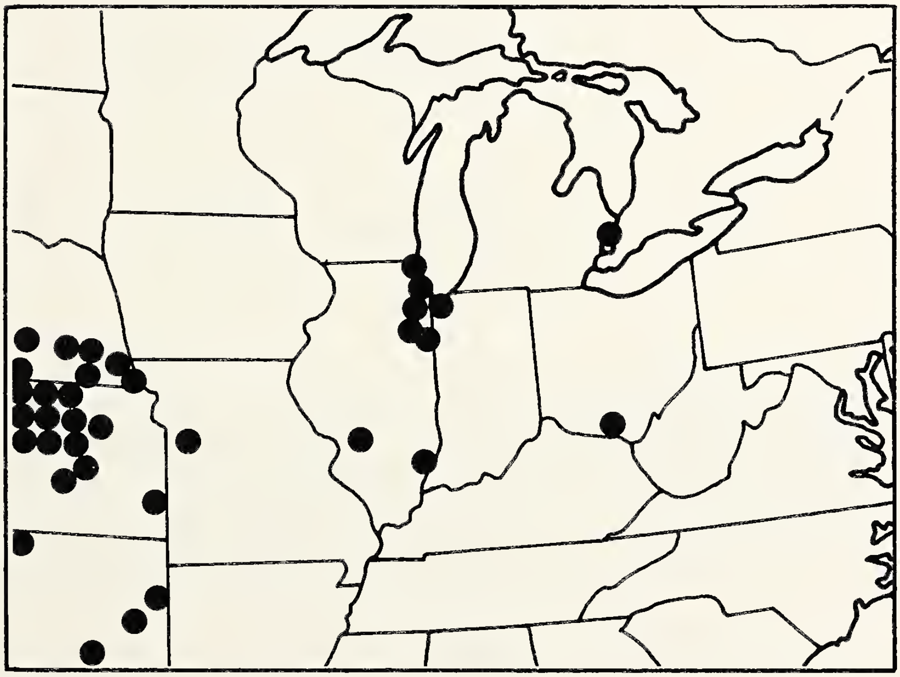


b

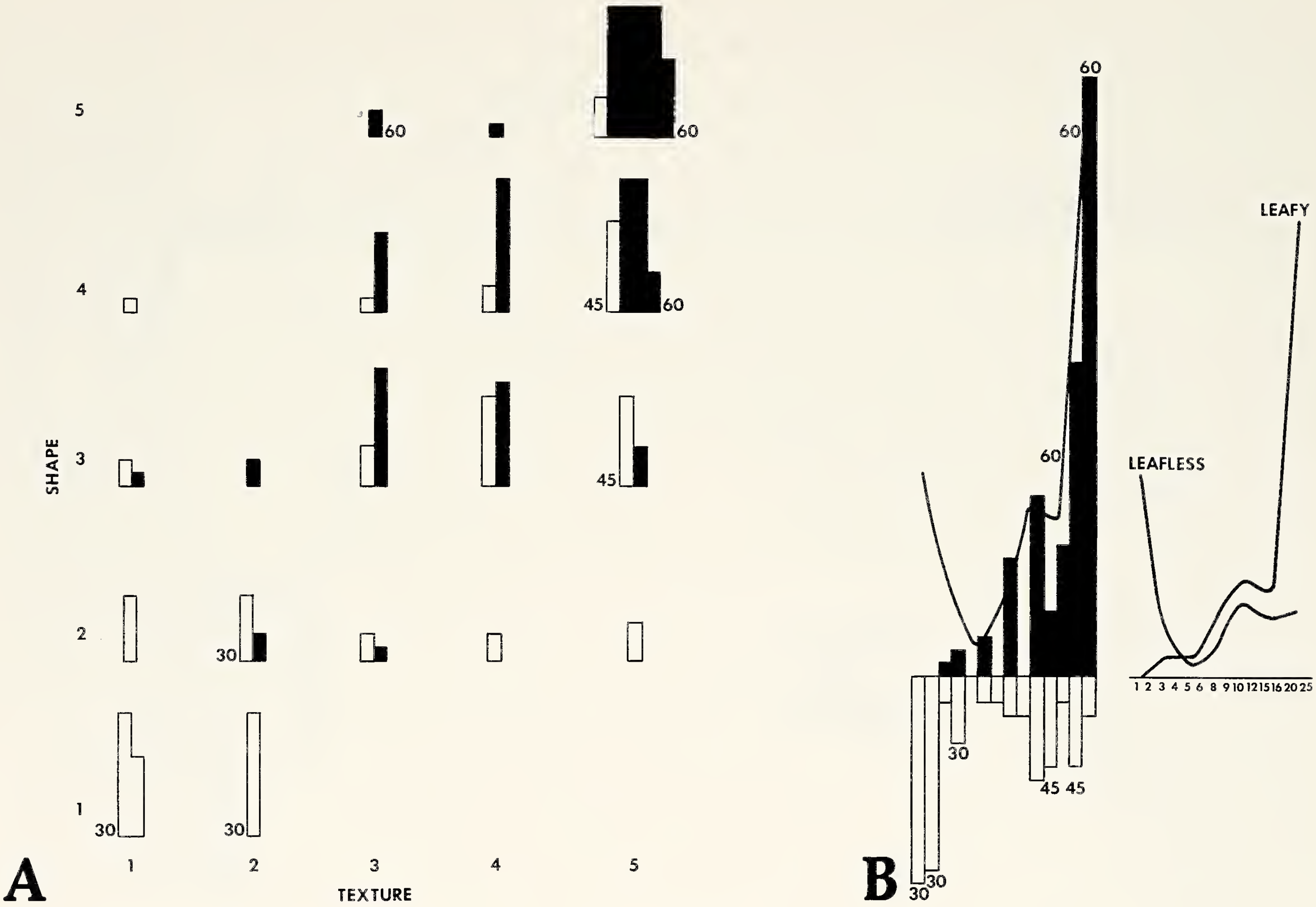
FIGURE 14: Distribution of combinations of three characters in *S. magnicamporum* and *S. cernua* in the western Great Lakes region based on specimens at ILL, ILLS, MIL, and collections made by the author. Specimens are plotted as leafy (black) or leafless (white). Lip characters are ranked on arbitrary scales of 1 to 5 (shape: ovate-oblong without basal dilation = 1, with an orbicular dilated base = 5; & texture: strongly thickened and fleshy = 1, wholly membranaceous = 5). Known chromosome numbers (2n) are plotted adjacent to the appropriate columns.

a: Scatter diagram of combinations of the two lip characters.

b: Lip character combinations in "a" expressed as a function of a hybrid index (shape X texture).

Left: The line plots two-point sliding means of the total sample.

Right: The lines plot two-point sliding means of the leafy and leafless components of sample.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SHAPE
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4
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2
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TEXTURE
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B
LEAFY
LEAFLESS
1 2 3 4 5 6 8 9 10 12 15 16 20 25
60
60
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30
30
30
45 45

FIGURE 15:

Spiranthes odorata

a: plant, X 0.4; *Sheviak 814*, Manatee Co., Florida (from photograph, *in hort.*).

b: flower, lateral view, X 3.1; *Sheviak 814*, Manatee Co., Florida (from photograph, in the field).

c: flower, lateral view, X 3.1; *Sheviak 817*, Collier Co., Florida (from photograph).

d: lip, X 3.2; *Sheviak 917*, Sarasota Co., Florida.

e: flower, front view, X 3.1; *Sheviak 817*, Collier Co., Florida (from photograph).

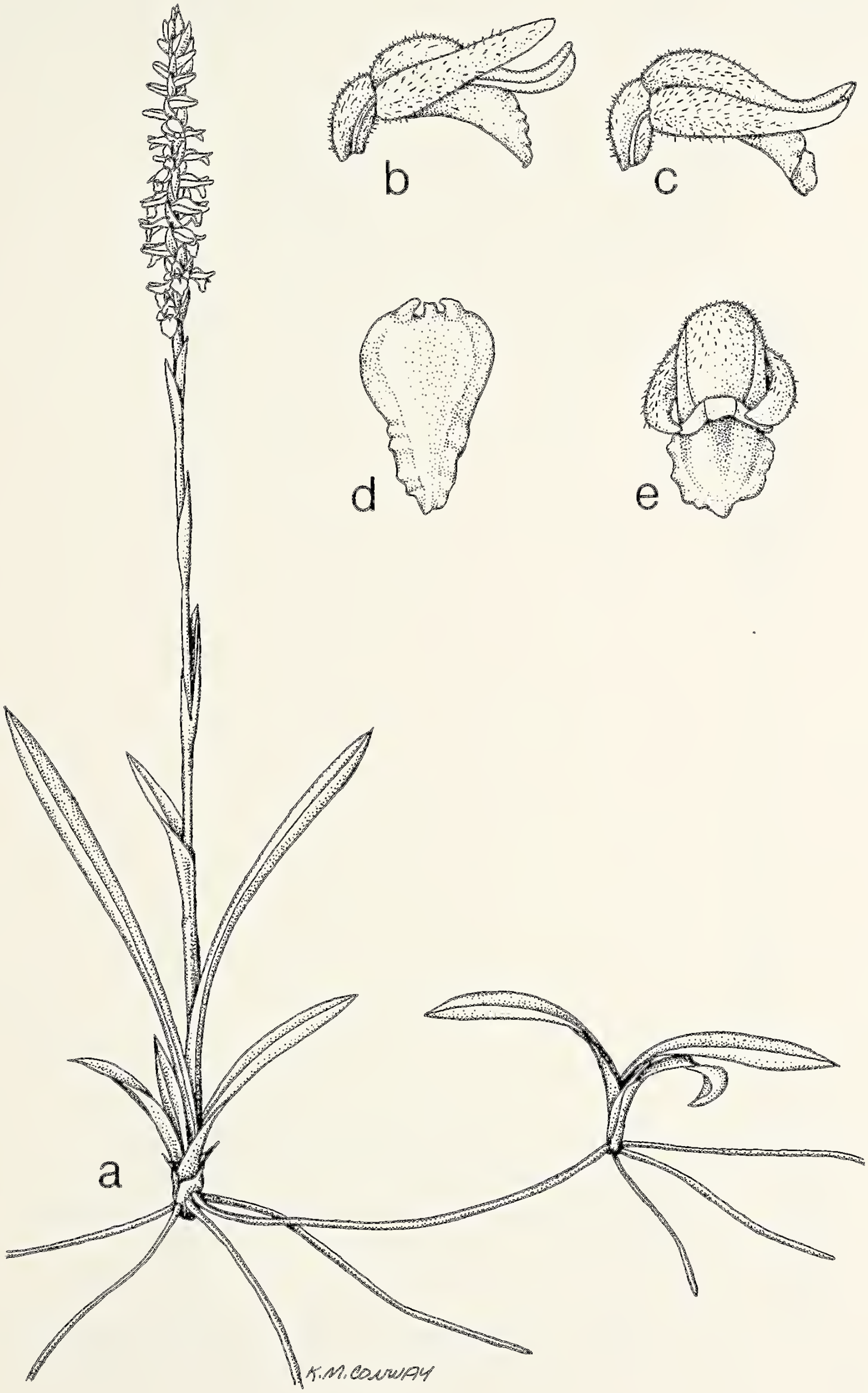
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FIGURE 16

Spiranthes ochroleuca

a: plant, X 0.6; *Sheviak 877*, Sullivan Co., New Hampshire (from photograph).

b: flower, lateral view, X 2.7; *Sheviak 915*, Sagadahoc Co., Maine (from photograph).

c: flower, front view, X 2.7; *Sheviak 915*, Sagadahoc Co., Maine (from photograph).

d: lip, X 3.2; *Sheviak 1962*, Cattaraugus Co., New York.

Spiranthes magnicamporum

e: plant, X 0.5; *Sheviak & Sheviak 1302*, Richland Co., North Dakota (from photograph).

f: flower, lateral view, X 2.8; *Sheviak 362b*, Lake Co., Illinois (from photograph).

g: flower, front view, X 2.8; *Sheviak 362b*, Lake Co., Illinois (from photograph).

h: lip, X 3.1; *Sheviak 362b*, Lake Co., Illinois.

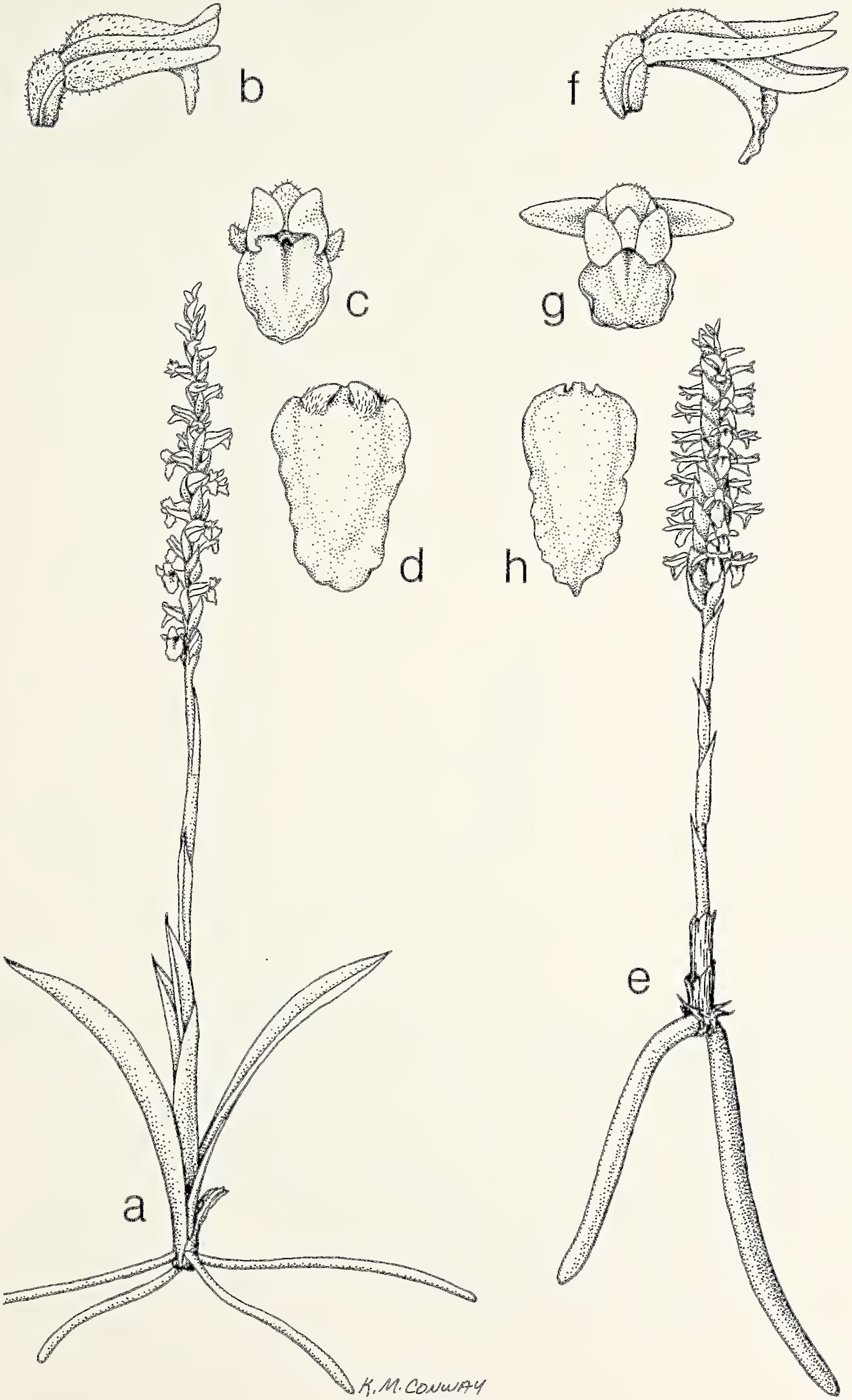
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FIGURE 17

Spiranthes cernua

The characteristic form of moist sandy and peaty soils throughout the Northeast, the Great Lakes region, and along the Appalachians. The "sand prairie ecotype" of Sheviak (1974b). 2n=60.

a: plant, X 0.6; *Sheviak s.n.*, Lake Co., Illinois (from photograph).

b: flower, lateral view, X 3.2; *Sheviak 2169*, Orleans Co., New York (from photograph).

c: flower, front view, X 3.2; *Sheviak 2169*, Orleans Co., New York (from photograph).

d: lip, X 4.0; *Sheviak 891*, Worcester Co., Massachusetts.

e: lip, X 4.0; *Sheviak & Sheviak 1313*, Winnebago Co., Illinois.

f: lip, X 4.0; *Jones 16673*, Kankakee Co., Illinois.

g: lip, X 4.0; *Catling s.n.*, Halburton Co., Ontario.

h: lip, X 4.0; *Sheviak 988/1*, Erie Co., Pennsylvania.

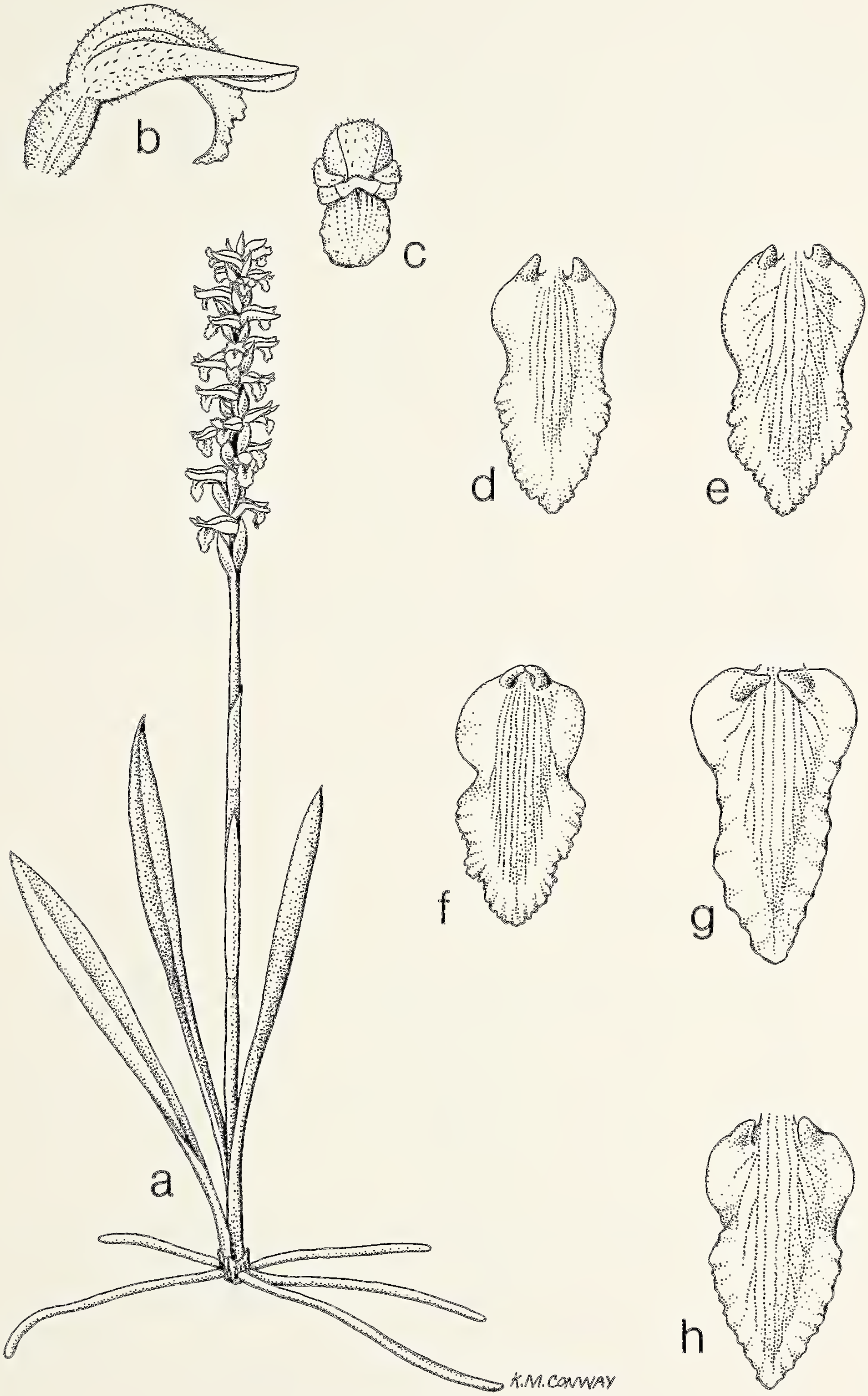
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FIGURE 18

Spiranthes cernua

Forms typical of moist roadcut banks and similar sites in New England and adjacent New York. These plants commonly occur with *S. ochroleuca* and more typical forms of *S. cernua*, and occasionally with the form illustrated in Figure 19a-d.

a-d: 2n=45.

- a: plant, X 0.8; *Sheviak & Sheviak 1123*, Belknap Co., New Hampshire (from photograph).
- b: flower, lateral view, X 3.6; *Sheviak & Sheviak 1123*, Belknap Co., New Hampshire (from photograph).
- c: flower, front view, X 3.6; *Sheviak & Sheviak 1123*, Belknap Co., New Hampshire (from photograph).
- d: lip, X 3.6; *Sheviak & Sheviak 1034*, Sullivan Co., New Hampshire (from photograph).

e-h: 2n=60.

- e: plant, X 0.8; *Sheviak 875*, Merrimack Co., New Hampshire (from photograph).
- f: flower, lateral view, X 3.6; *Sheviak & Sheviak 1036h*, Sullivan Co., New Hampshire (from photograph).
- g: flower, front view, X 3.6; *Sheviak & Sheviak 1036h*, Sullivan Co., New Hampshire (from photograph).
- h: lip, X 3.6; *Sheviak & Sheviak 1036h*, Sullivan Co., New Hampshire (from photograph).

i-l: 2n=61.

- i: inflorescence, X 0.8; *Sheviak & Sheviak 1036b*, Sullivan Co., New Hampshire (from photograph).
- j: flower, lateral view, X 3.6; *Sheviak & Sheviak 1036b*, Sullivan Co., New Hampshire (from photograph).
- k: flower, front view, X 3.6; *Sheviak & Sheviak 1036b*, Sullivan Co., New Hampshire (from photograph).
- l: lip, X 3.6; *Sheviak & Sheviak 1036b*, Sullivan Co., New Hampshire.

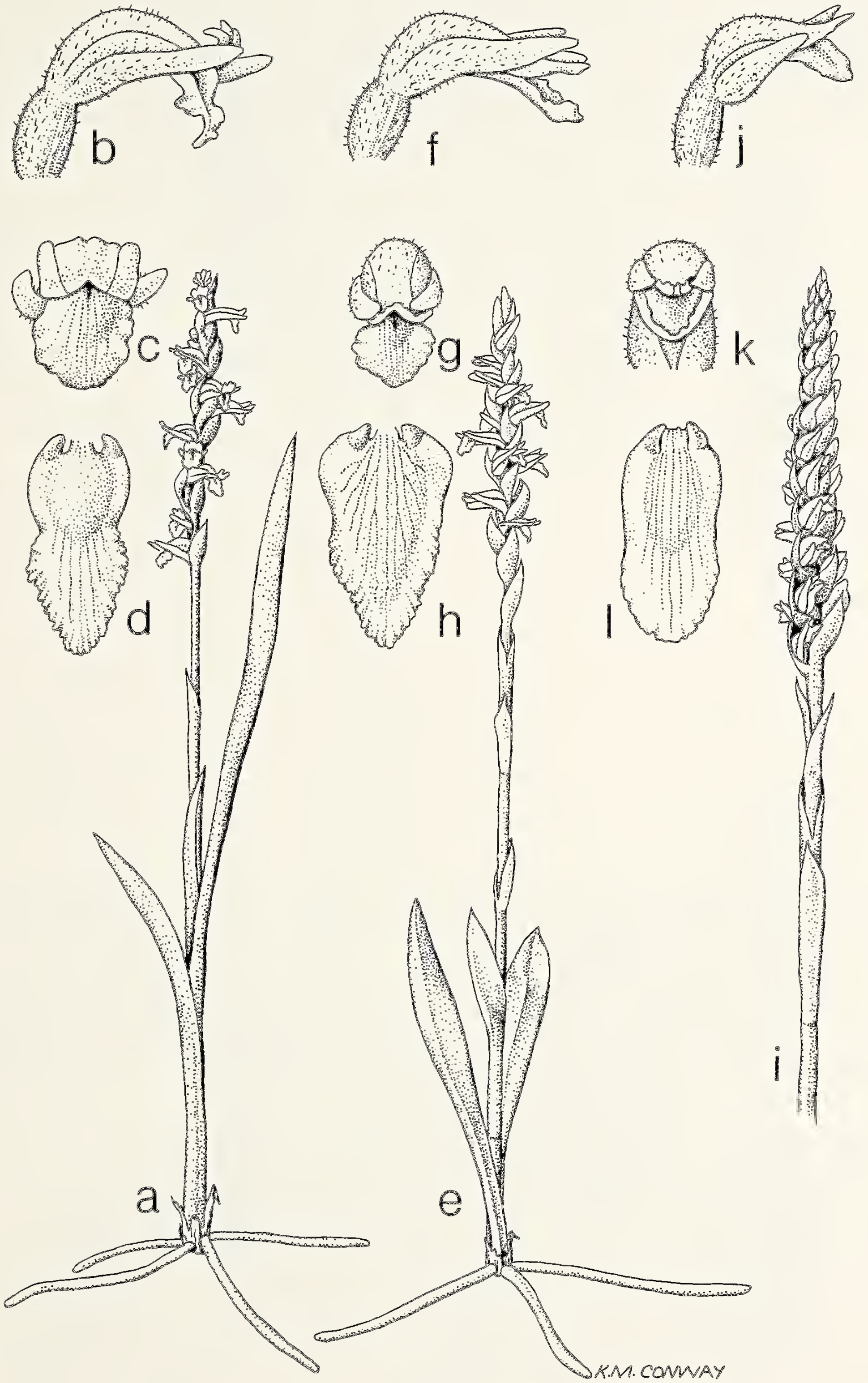
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FIGURE 19

Spiranthes cernua

a-d: A form common in dry to moist sand, especially in excavated sites, in New England and New York. Perhaps var. *major* Eaton. 2n=*ca.* 60.

a: plant, X 0.8; *Sheviak & Sheviak 1043c*, Windham Co., Vermont (from photograph).

b: flower, lateral view, X 2.4; *Sheviak 884*, Middlesex Co., Massachusetts (from photograph).

c: flower, front view, X 2.4; *Sheviak 884*, Middlesex Co., Massachusetts (from photograph).

d: lip, X 3.6; *Sheviak 1654c*, Hamilton Co., New York.

e-j: Variation common in the western Great Lakes region. 2n=60.

e: inflorescence, X 0.7; *Sheviak 398*, Lake Co., Illinois (from photograph).

f: flower, lateral view, X 2.2; *Sheviak 398*, Lake Co., Illinois (from photograph).

g: flower, front view, X 2.2; *Sheviak 398*, Lake Co., Illinois (from photograph).

h: lip, X 3.9; *Sheviak 182*, Cook Co., Illinois.

i: lip, X 3.9; *Sheviak 402*, Lake Co., Illinois.

j: lip, X 3.9; *Sheviak 179*, Lake Co., Illinois.

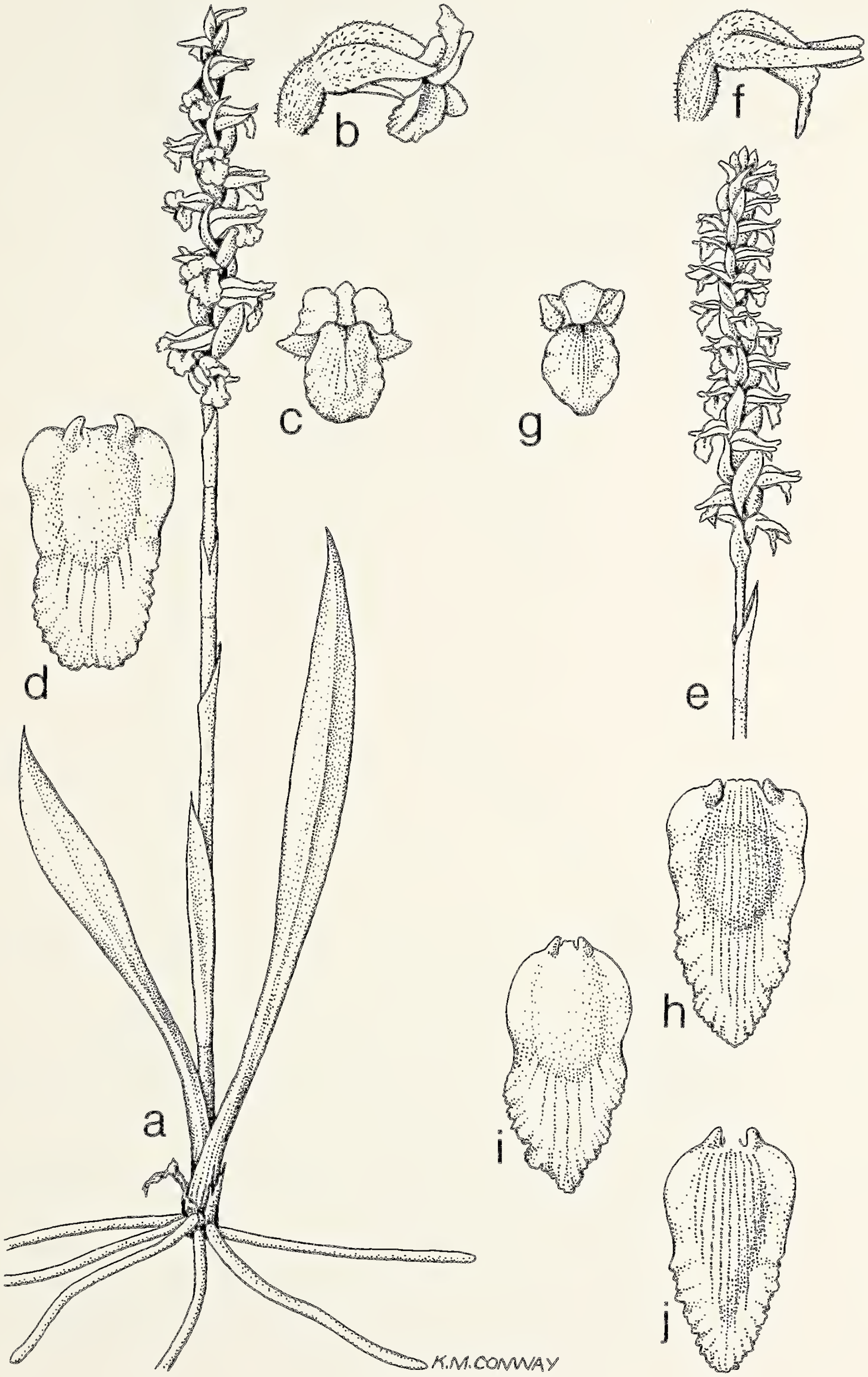
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FIGURE 20

Spiranthes cernua

a-d: The "low prairie race" of Sheviak (1973, 1974b); a plant of low, calcareous, black-soil prairies in Illinois, Wisconsin, and Iowa. 2n=45.

a: plant, X 0.8; *Sheviak et al. 1314,* Dekalb Co., Illinois (from photograph).

b: flower, lateral view, X 2.7; *Sheviak et al. 1314,* Dekalb Co., Illinois (from photograph).

c: flower, front view, X 2.7; *Sheviak et al. 1314,* Dekalb Co., Illinois (from photograph).

d: lip, X 3.6; *Sheviak 698,* Kankakee Co., Illinois.

e-h: The "old field ecotype" of Sheviak (1974b); a plant of acidic old fields and woodland openings in the lower Midwest and South. 2n=60.

e: plant, X 0.7; *Sheviak 706,* Pope Co., Illinois (from photograph).

f: flower, front view, X 3.6; *Sheviak 706,* Pope Co., Illinois (from photograph).

g: flower, lateral view, X 3.6; *Sheviak 706,* Pope Co., Illinois (from photograph).

h: lip, X 3.6; *Sheviak et al. 985,* Champaign Co., Illinois.

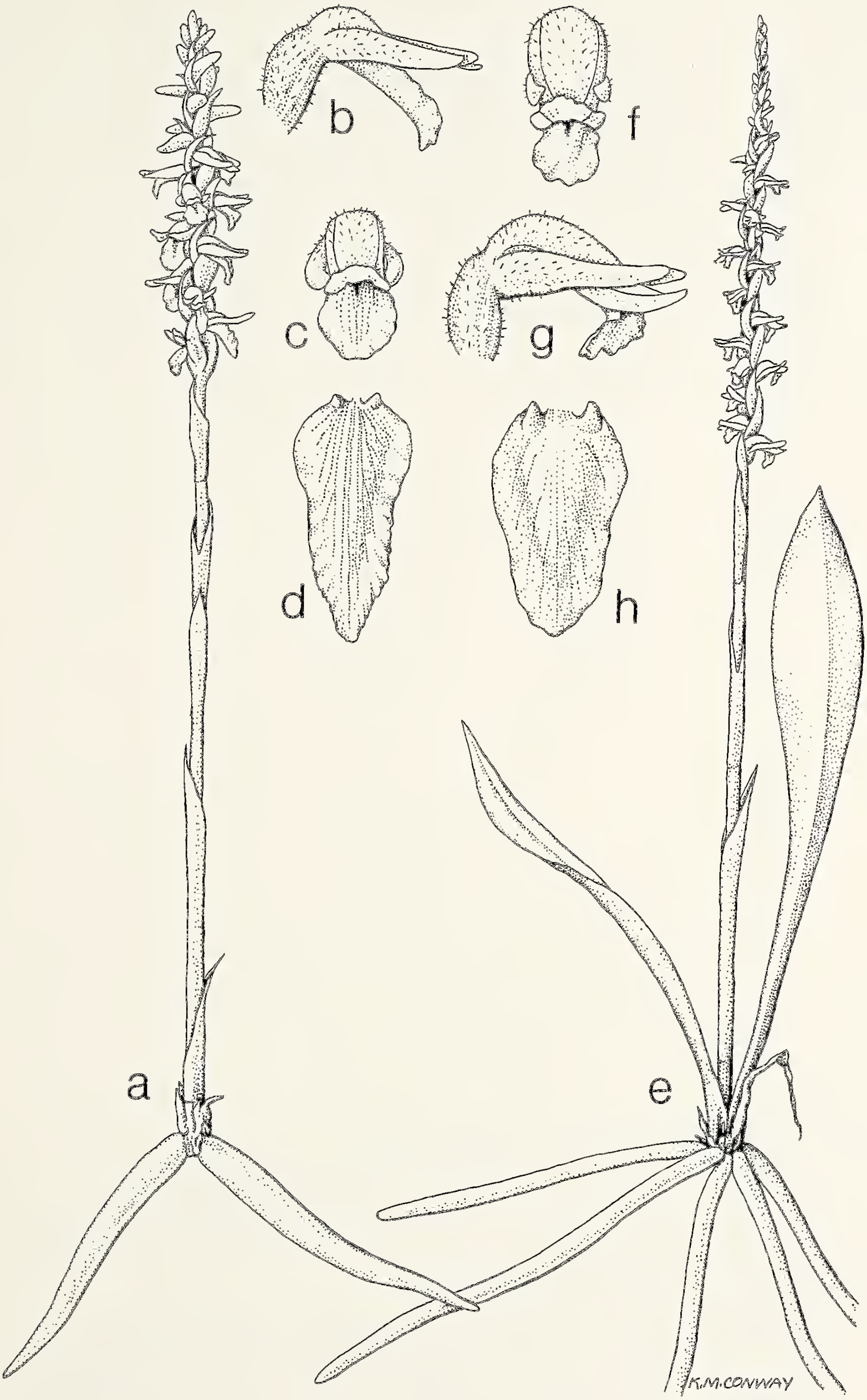
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FIGURE 21

Spiranthes cernua

Typical forms of the southern prairies complex. 2n=60.

a: plant, X 0.5; *Sheviak et al. 981/2*, Bond Co., Illinois (from photograph).

b: flower, lateral view, X 2.4; *Sheviak et al. 981/2*, Bond Co., Illinois (from photograph).

c: flower, front view, X 2.4; *Sheviak et al. 981/2*, Bond Co., Illinois (from photograph).

d: lip, X 3.6; *Sheviak et al. 981/2*, Bond Co., Illinois.

e: plant, X 0.5; *Sheviak et al. 981a*, Bond Co., Illinois (from photograph).

f: flower, front view, X 2.4; *Sheviak et al. 981a*, Bond Co., Illinois (from photograph).

g: flower, lateral view, X 2.4; *Sheviak et al. 981a*, Bond Co., Illinois (from photograph).

h: lip, X 3.6; *Sheviak et al. 981a*, Bond Co., Illinois.

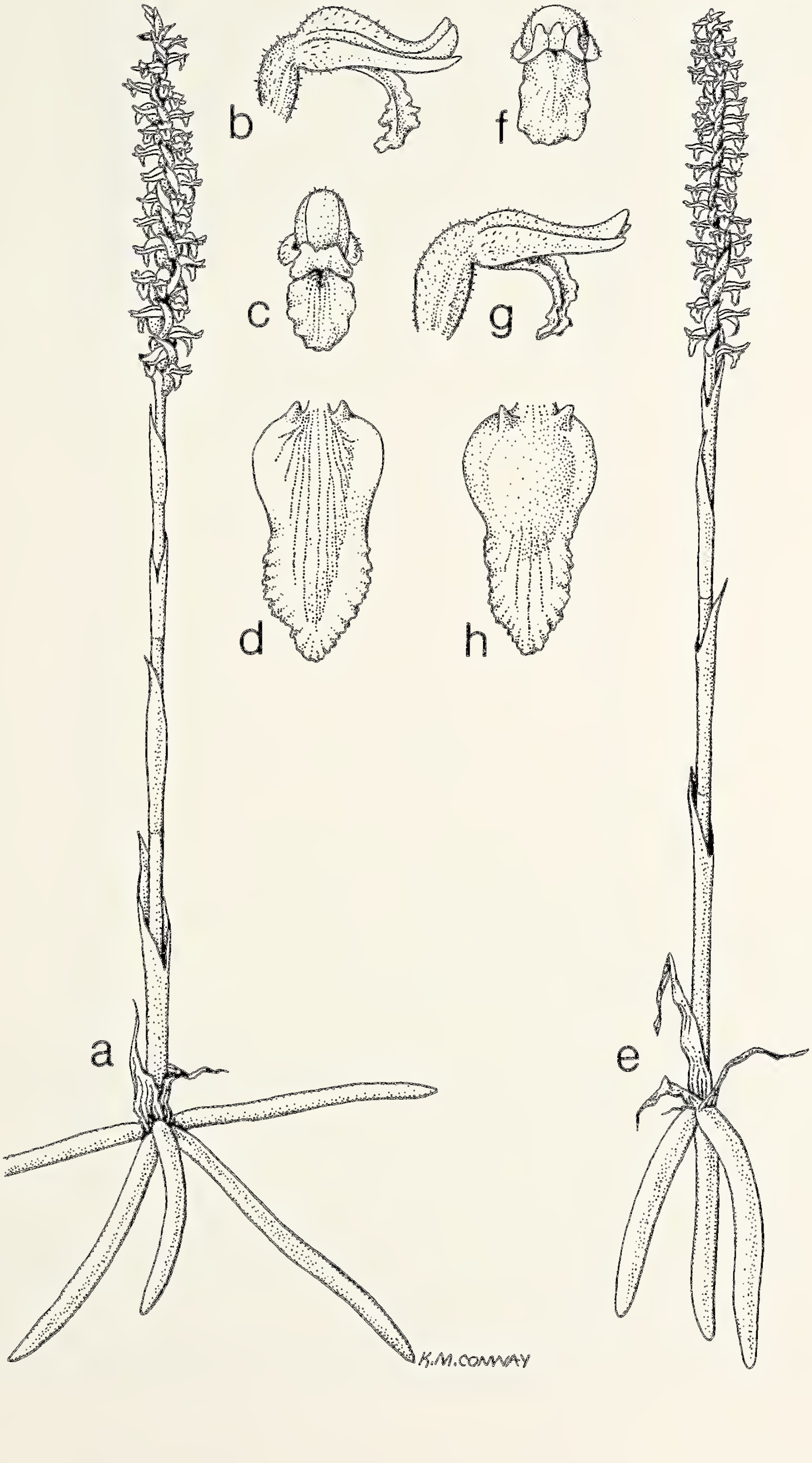
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FIGURE 22

Spiranthes cernua

Typical forms of the southern prairies complex.

a-d: 2n=60.

a: plant, X 0.5; *Sheviak & Sheviak 976f,* Bourbon Co., Kansas (from photograph).

b-c: flowers, lateral view, X 2.4; *Sheviak & Sheviak 976f,* Bourbon Co., Kansas (from photograph).

d: lip, X 3.6; *Sheviak et al. 981c,* Bond Co., Illinois.

e-g: Cleistapogamous form. 2n=62.

e: plant, X 0.5; *Sheviak 1015,* Bond Co., Illinois (from photograph).

f: flower, lateral view, X 2.4; *Sheviak 1015,* Bond Co., Illinois (from photograph).

g: lip, X 3.6; *Sheviak 1016,* Bond Co., Illinois.

h: Cleistapogamous form from sand prairies in the western Great Lakes region. Base of plant, X 0.5. Otherwise as in e-g; *Sheviak & Niemann 900a,* Kankakee Co., Illinois.

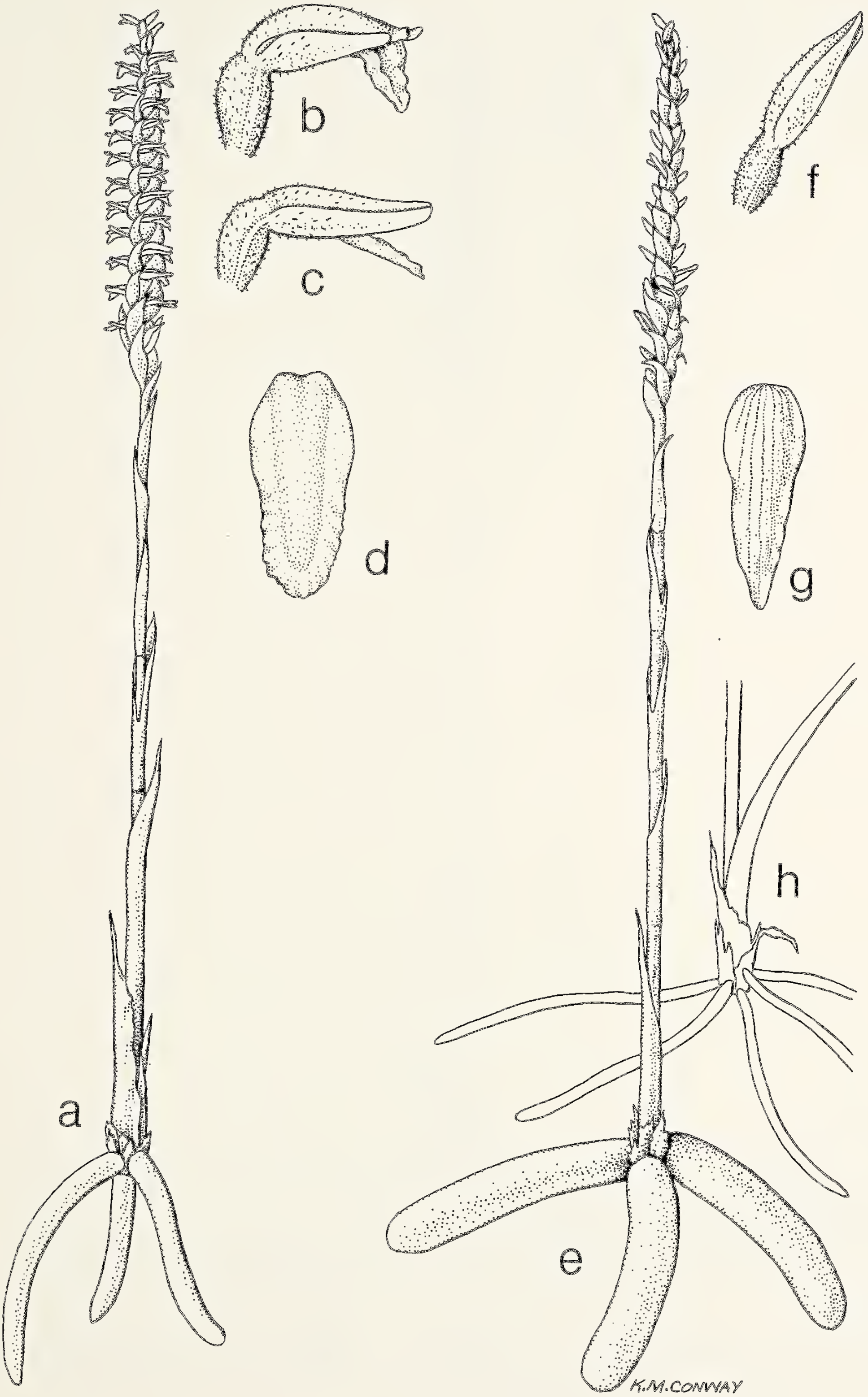
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FIGURE 23

Spiranthes cernua

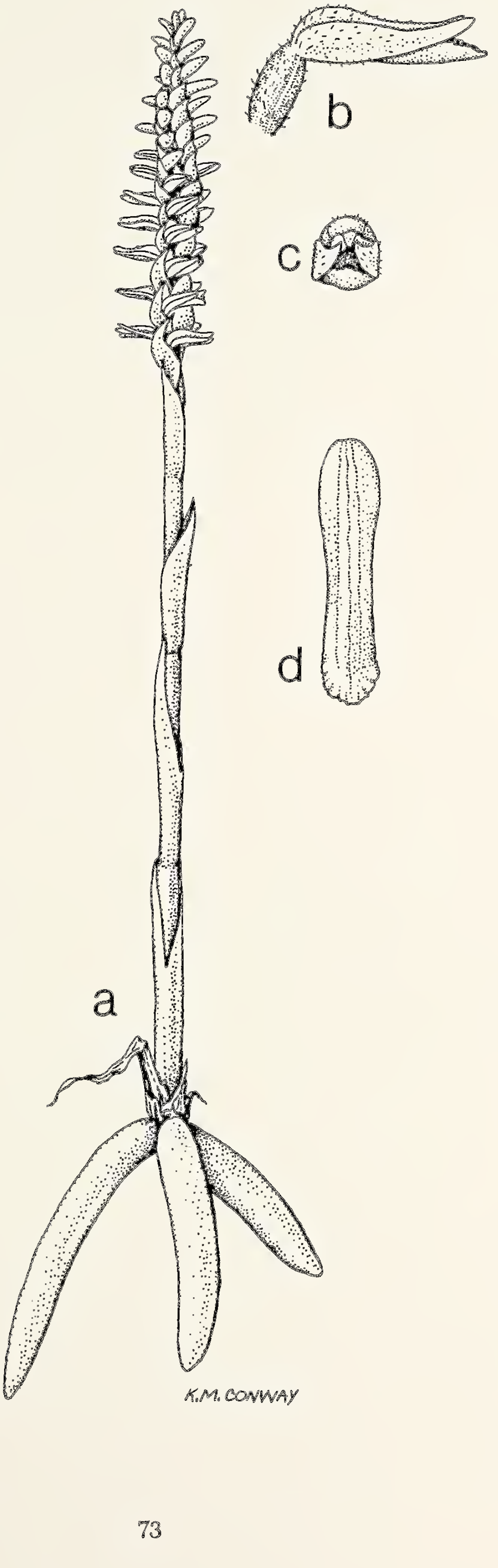
A peloric form which is an important member of the southern prairies complex in eastern Kansas and adjacent areas. 2n=*ca.* 60.

a: plant, X 0.6; *Sheviak & Niemann 947,* Waubansee Co., Kansas (from photograph).

b: flower, lateral view, X 2.4; *Sheviak & Niemann 947,* Waubansee Co., Kansas (from photograph).

c: flower, front view, X 2.4; *Sheviak & Niemann 947,* Waubansee Co., Kansas (from photograph).

d: lip, X 3.6; *Magrath 4913,* Washington Co., Kansas.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The Geology of the Pine Bush Aquifer, North-Central Albany County, New York

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by Robert J. Dineen
Senior Scientist, Geology

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August 1982

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The Geology of the Pine Bush Aquifer, North-Central Albany County, New York

by Robert J. Dineen

ABSTRACT

The Pine Bush aquifer, in the northeast corner of Albany County, between Albany and Schenectady, New York, is composed of a 3- to 16-meter-thick wedge of lake and dune sand, thickening towards the southeast. Silt content of the sand varies, with well-sorted sand dominating the north-central part of the aquifer and silty sand predominating peripherally. The water table is controlled by beds of impermeable lake silt and clay that underlie the aquifer, and localized lenses of clay within the aquifer cause perched water tables. Lenses of clay within the aquifer are cut by sand-filled channels that allow water to percolate into the underlying sands. Ground water flow is towards the east and southeast, following the dip of the basal silt and clay aquiclude. Well-sorted sand was probably deposited as an offshore bar system and the clay lens was deposited in a lagoon. Seismic refraction was effective to a depth of 50 meters for determining the depth to bedrock and the presence of till, whereas it was less effective in distinguishing between clay and water-saturated sand. Resistivity was useful in determining the location of the water table and the upper clay lenses to a depth of 10 meters.

ACKNOWLEDGEMENTS

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INTRODUCTION

The Pine Bush is a sand plain that is located in the mid-Hudson section of the Hudson-Champlain Lowlands, in Albany County between Albany and Schenectady, New York (Fig. 1A). The surface and near-surface sand that underlies the Pine Bush is the Pine Bush aquifer. Prior to the last glaciation, the Pine Bush was dissected by a trellis drainage system. The major north-south elements of the preglacial drainage system were the Mohawk, Colonie, and Batten Kill-Hudson channels (Broughton and others, 1966; Davis and Dineen, 1969). The Mohawk and Colonie channels underlie the Pine Bush (Dineen, 1975). Sand of the Pine Bush aquifer was deposited in glacial Lake Albany, on top of a thick sequence of lake sediments that filled the preglacial valleys (Fig. 1A). When at its largest, glacial Lake Albany extended from Glens Falls to Newburgh, New York, a distance of 260 km (160 miles), and lasted from 15,000 to 12,600 years B.P. (Before Present). The lake expanded during the northward retreat of the Hudson Valley Lobe of the Wisconsinan Ice Sheet. The lake received sand, gravel, and clay that were winnowed by meltwater from the Hudson Glacial Lobe. The lower part of the lake sediment section was deposited near the margin of the glacier and the lake, and tended to be sand and gravel. As the ice margin retreated, the sediments had to be carried further into the lake by weakening meltwater currents, so they became finer-grained. Thus, the glacier margin was a large distance away from sites where clay and silt were accumulating. The lake levels dropped as the glacier retreated, and delta fronts migrated across the rapidly shoaling lake, bringing sand in to cover the older clays. These sands were modified by the wind when the lake dried up, forming the dunes of the Pine Bush.

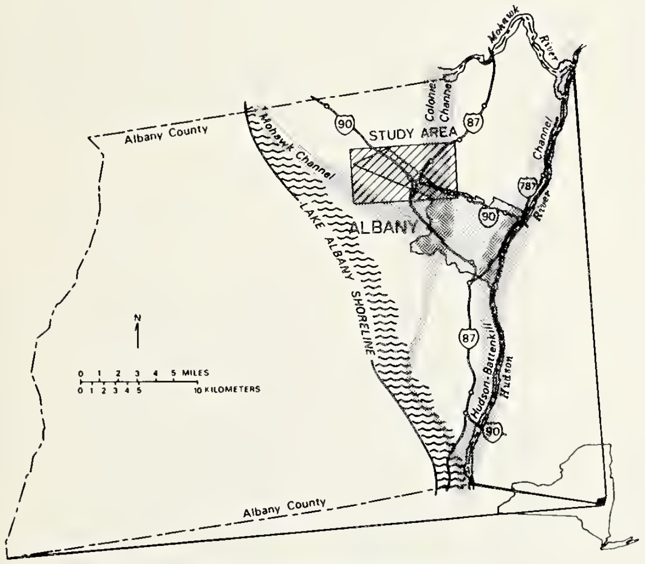

FIGURE 1A. LOCATION OF STUDY AREA

Simpson (1949) mapped the general trend of the buried valleys in Albany County, and expressed interest in the ground water potential of these features and the overlying lake deposits. Arnow (1949), Halberg and others (1964), Davis and Dineen (1969), Dineen (1975), and Dineen and Hanson (in prep.) have also worked on the buried valleys and lake deposits. Dineen (1975, 1977, in prep.) and Dineen, Rogers, and Buyce (1978) have mapped the surficial geology of the Pine Bush. Hanson (1979, personal communication) mapped a groundwater divide in the vicinity of the intersection of the Washington Ave. Extension and N.Y. Rt. 155. The City of Albany has recently initiated a hydrologic and geologic study of the eastern section of the Pine Bush aquifer to evaluate its potential as a water source for the Capital District. Geologic mapping, test well drilling, and geophysical studies have been conducted in order to map the geologic environment of the aquifer. These data are present in Appendices 2 (Seismic), 3 (Resistivity), and 4 (Wells). The combined surface and subsurface data have been used to define the geologic units and to map their vertical and areal distribution.

GEOPHYSICS

Seismic refraction and electrical resistivity were used to: 1) determine the depth of the water table, 2) find the depths of the contacts of the glacial units, 3) trace the local aquicludes, and 4) find the depth to bedrock. Geologic units rarely show a unique geophysical character so both geophysical techniques were used to aid interpretation.

Seismic Refraction

I used the time-intercept method of seismic refraction interpretation (Mooney, 1979 and Griffiths and King, 1965) on seismic lines collected by using a 7.3 kg (16-pound) sledge hammer as the signal source for a Huntec FS-3 portable seismograph. The seismic

AGE		UNIT	MAP SYMBOL	DESCRIPTION	SEDIMENTARY STRUCTURE	THICKNESS: METERS	NOTES
RECENT		ARTIFICIAL FILL	AF	Heterogeneous, with concrete fragments, boulders, cobbles, sand, silt, clay, and organic matter. Color is variable.	Massive to thickly bedded.	0.3 to 15, 1 average	Permeable to impermeable, loose to very compact, can contain leachable materials and chemicals.
		Unconformity					
HOLOCENE		DUNE SAND	QDS	Slightly silty, light yellow brown, fine to very fine sand, grains are subangular to subrounded.	Cross-bedded, >15° dip	1.5 to 30, 6 average	Highly permeable, loose, weathered to 6m, readily eroded by wind and water.
		Disconformity					
PLEISTOCENE	Woodfordian	LAKE ALBANY SAND	QLAS	Slightly silty, light yellow brown to light gray, subangular, medium to very fine sand.	Thin bedding, some ripple cross-laminae.	0.3 to 15, 1 average	Highly to moderately permeable (vertical permeability impeded where silt layers are present), loose to compact, unstable in steep slopes, easily eroded by water.
		300 FT. CLAY	QLAV	Silty, varved, light gray to light brown clay, siltier at top and bottom.	Varves and 0.3m beds	0.3 to 5, 1 average	Impermeable, plastic, unstable in slopes, spring lines form at upper contact with sand, is an aquiclude, impedes vertical water movement.
		Disconformity to gradational contact					
		LAKE ALBANY SILT & SAND	QLAM	Silty to very silty, light yellow brown to light gray sand.	Horizontal to ripple laminated.	0.3 to 15, 8 average	Moderately permeable, loose to compact, silt unstable in steep slopes, impedes water movement and "clouds" water, erodes easily by water.
		Disconformity to gradational contact					
		LAKE ALBANY SILT & CLAY	QLAC	Varved, brown to gray silty clay and clayey silt, trace sandy beds.	Varves with ripple cross-laminated silt beds.	8 to 50 15average	Impermeable, plastic, some water movement along silt beds, flows or slumps in slopes >12°, flows under load, is aquiclude.
		Unconformity to gradational contact					
		ICE-CONTACT SAND & GRAVEL	QI	Stratified brown to dark gray gravel to silty sand and gravel, tends to fine upward into silt.	Graded bedding is frequent, ripple-laminated (sand & silt).	0.3 to 3	Permeable, loose to compact, water is frequently under artesian pressure.
		Unconformity to disconformity					
		TILL	QT	Dark gray to dark brown, bouldery, gravelly, sandy clay with few lenses of gravel.	Massive	1.5 to 15, 5 average	Impermeable, compact, sometimes permeable at base.
		Unconformity					
ORDOVICIAN		BEDROCK		Black shale and dark gray graywacke	Well bedded		Impermeable, and compact except where fractured.

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TABLE 1. SUMMARY OF GLACIAL DEPOSITS IN THE PINE BUSH

traverses were located along dirt roads and footpaths, in areas isolated from highways and powerlines, to facilitate ready access and to reduce noise. Traverses were 98.4 m (300 feet) long, hammer shot points were 3.28 m (10 feet) apart, and every traverse was reversed. The data are summarized in Appendix 2.

Generally, two or three seismic layers were visible in the seismic records, although traverse 79-6s showed four layers. Figures 1B through 1D show the areal distribution of seismic velocities for each layer. These figures show velocity changes that are related to the changes in physical properties of the layer, such as compaction, density, bulk grain size, or water content (see Table 2).

Seismic Layer V_1

The V_1 seismic velocities represent the surface layer or zone, and range between 800 ft/sec and 2,250 ft/sec (Fig. 1B). Higher V_1 velocities tend to occur over the bedrock terrace, with the lower velocities over the buried channels. The velocities that are greater than 1,500 ft/sec seem to coincide with the areal distribution of silty sand and the upper clay. The V_1 layer is a dry, loosely to moderately compacted, silty fine- to medium-grained sand.

Seismic Layer V_2

Seismic velocities in the second seismic layer range between 3,000 ft/sec and 6,200 ft/sec (Fig. 1C). Two areas of seismic velocities greater than 4,500 ft/sec exist; the western high velocity zone overlies the bedrock terrace, and the eastern high-velocity zone overlies the Colonie Channel. Generally, V_2 is saturated silty sand and silt and clay. Seismic line 79-6s had an additional V_2 of 7,300 ft/sec.

Seismic Layer V_3

The velocity distribution of V_3 is between 10,500 ft/sec and 20,000 ft/sec (Fig. 1D). The velocities that exceed 12,500 ft/sec coincide with the bedrock terrace of the Colonie Channel. A narrow, 12,500 ft/sec, low-velocity zone cuts across the eastern side of the bedrock terrace; and a larger low-velocity area coincides with the Mohawk Channel. Test borings indicate that V_3 is bedrock.

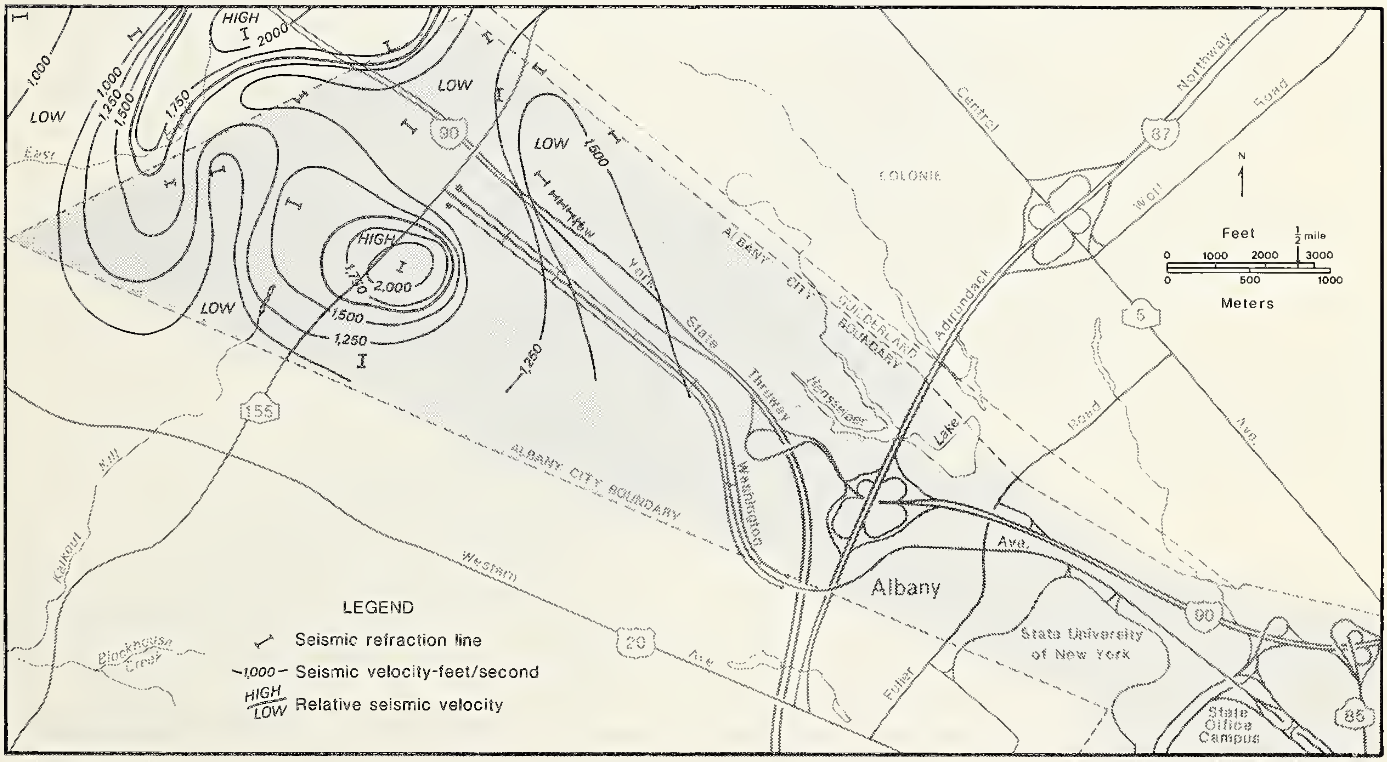

FIGURE 1B. SEISMIC VELOCITIES IN LAYER V_1

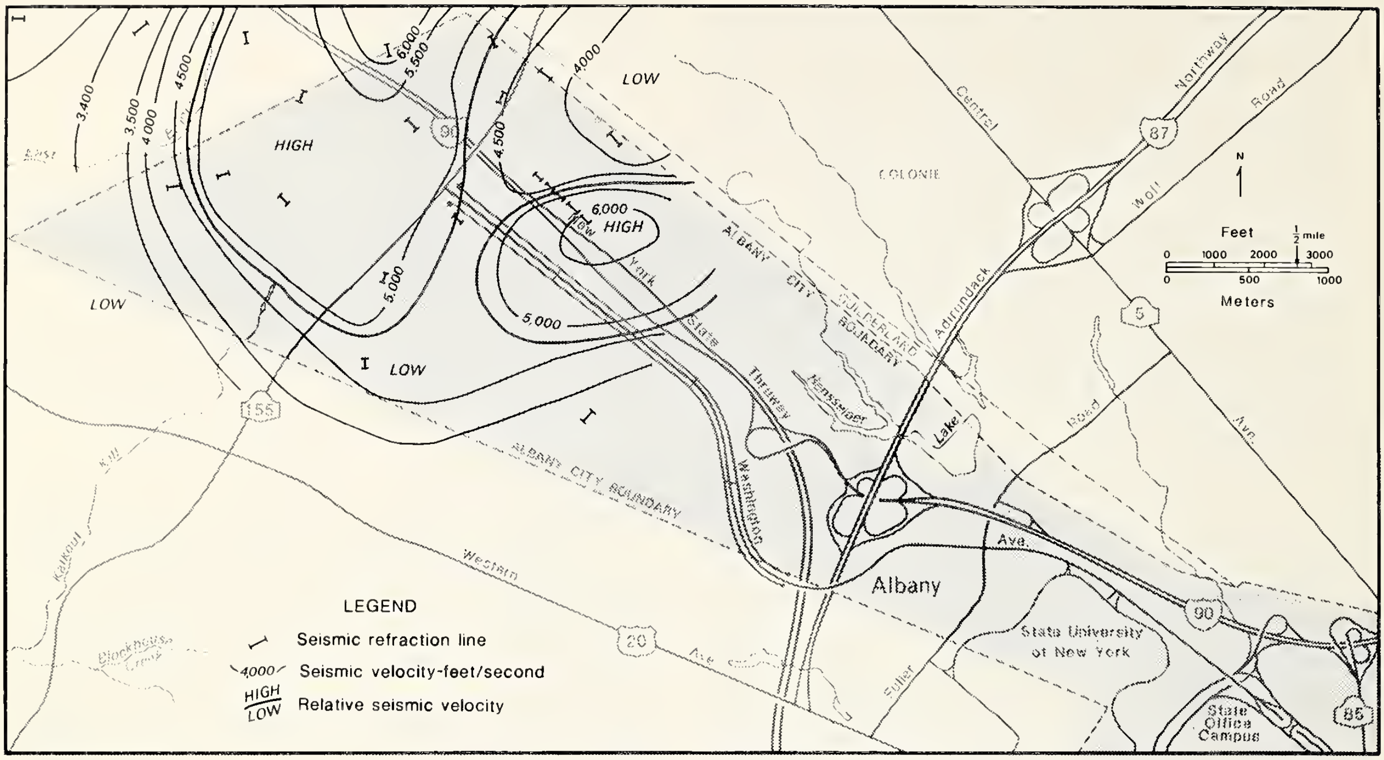

FIGURE 1C. SEISMIC VELOCITIES IN LAYER V_2

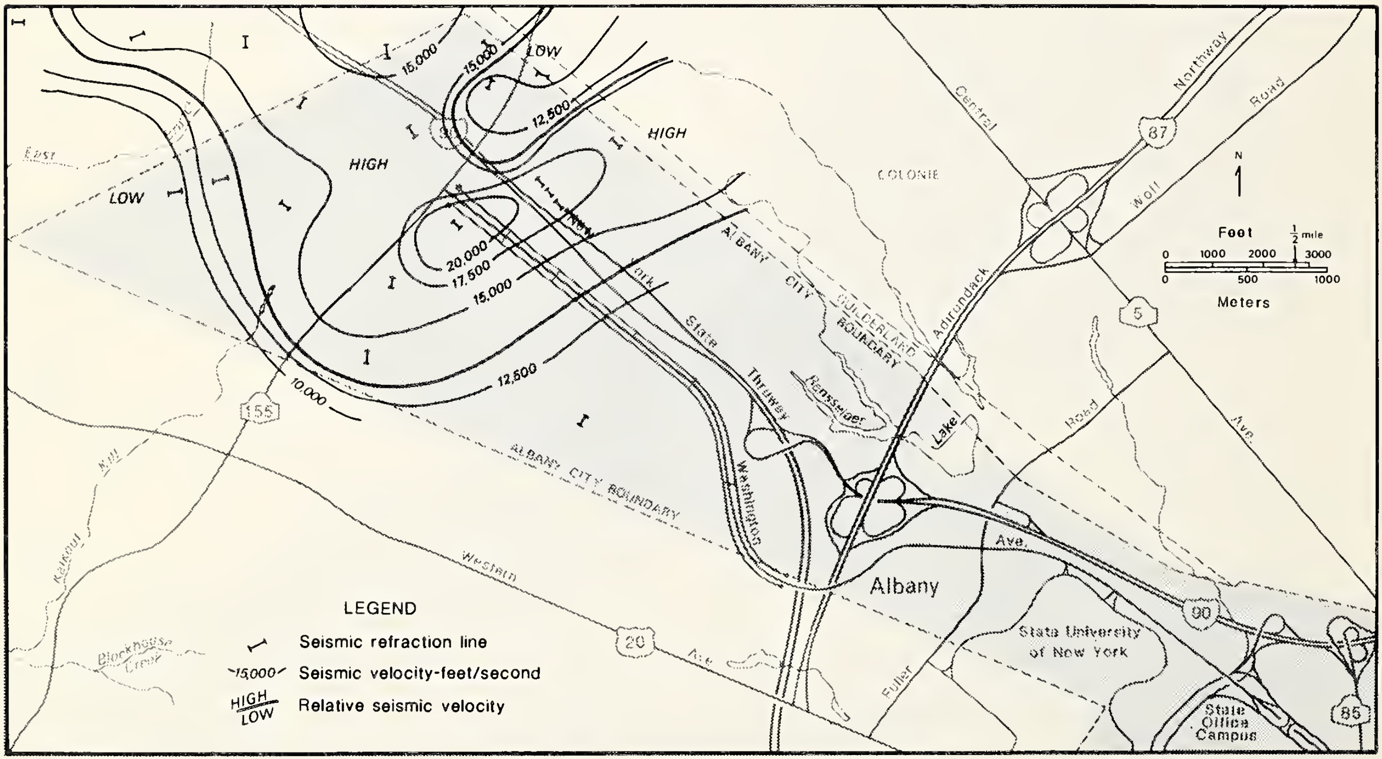

FIGURE 1D. SEISMIC VELOCITIES IN LAYER V_3

TABLE 2A Geophysical Units

	Seismic	Resistivity	
Layer	Velocity (Ft/Sec)	A-Spacing (Ft)	Resistivity (Ω/Ft)
V_1	800– 2,250	15	1,500–10,000
V_{2a}	3,000– 6,200	30	1,000– 8,000
V_{2b}	7,300	60	3,000– 7,500
V_3	10,500–20,000	90	500–10,000

TABLE 2B Geophysical Interpretation

Geologic Unit	Seismic Velocity (Ft/Sec)	Resistivity (Ω/Ft)
Dry sand	800– 2,000	3,000– 8,000
Wet sand, silty sand	1,500– 2,500	1,000– 3,000
Wet silt and clay	3,000– 4,500	500– 1,500
Over-compact clay or silty sand	4,500– 6,000	500– 2,000
Till	5,000– 7,500	8,000–15,000
Bedrock	10,500–20,000	10,000–20,000

Electrical Resistivity

A Bison Instruments Model 2350B electrical resistivity meter was used to obtain electrical resistivity data. I used the four-electrode sounding method in the Wenner configuration (Zohdy and others, 1974, and Parasnis, 1962). The data are summarized in Appendix 3. The earth resistivities were measured when the distance between electrodes were at the 15-, 30-, 60-, and 90-foot (4.9-, 9.8-, 19.7-, 29.5-meter) A-Spacings (Figures 2A through 2D). Generally, the electric current is able to penetrate deeper at wider A-Spacings. Therefore the resistivity logs indicate a general measure of the electrical properties at depths that approximate the A-Spacing.

Resistivities at the 15-foot A-Spacing

The resistivities at the 15-foot (4.9 meter) A-Spacing range between 1,500 Ω/ft and 10,000 Ω/ft (Fig. 2A). The relatively low resistivities are less than 3,000 Ω/ft and are probably silty sand, and high resistivities are greater than 3,000 Ω/ft and are probably sand. Wedges of high-resistivity extend into the low resistivity area from the south, northeast, and northwest.

Resistivities at the 30-foot A-Spacing

The resistivity recorded for an A-Spacing of 30 feet (9.8 meters) ranges between 1,000 Ω/ft and 8,000 Ω/ft, although most readings are less than 3,000 Ω/ft (Fig. 2B). Two areas are dominated by high resistivity: a western arc that overlies the highest section of the bedrock terrace and projects southward towards the Mohawk Channel that is probably wet sand, and a small, intense eastern high that overlies an area with seismic velocities 7,000 ft/sec in seismic line 79-6s, the only seismic line recording four seismic layers, that is probably till.

Resistivities at the 60-foot A-Spacing

The resistivities recorded at the 60-foot (19.7-meter) A-Spacing are generally lower than those recorded at the 30-foot A-Spacing (Fig. 2C). The range in resistivities is between 500 Ω/ft and 7,500 Ω/ft, although most of the readings are less than 2,000 Ω/ft. Resistivities are highest in areas underlain by silty sand and lowest in areas underlain by silt and clay.

Resistivities at the 90-foot A-Spacing

The resistivities at the 90-foot (29.5 meter) A-Spacing range between 900 Ω/ft and 10,000 Ω/ft with most of the readings less than 10,000 Ω/ft (Fig. 2D). The distribution of resistivy greater than 5,000 Ω/ft is similar to the distribution of V_3 seismic velocities less than 12,500 ft/sec, and is probably till.

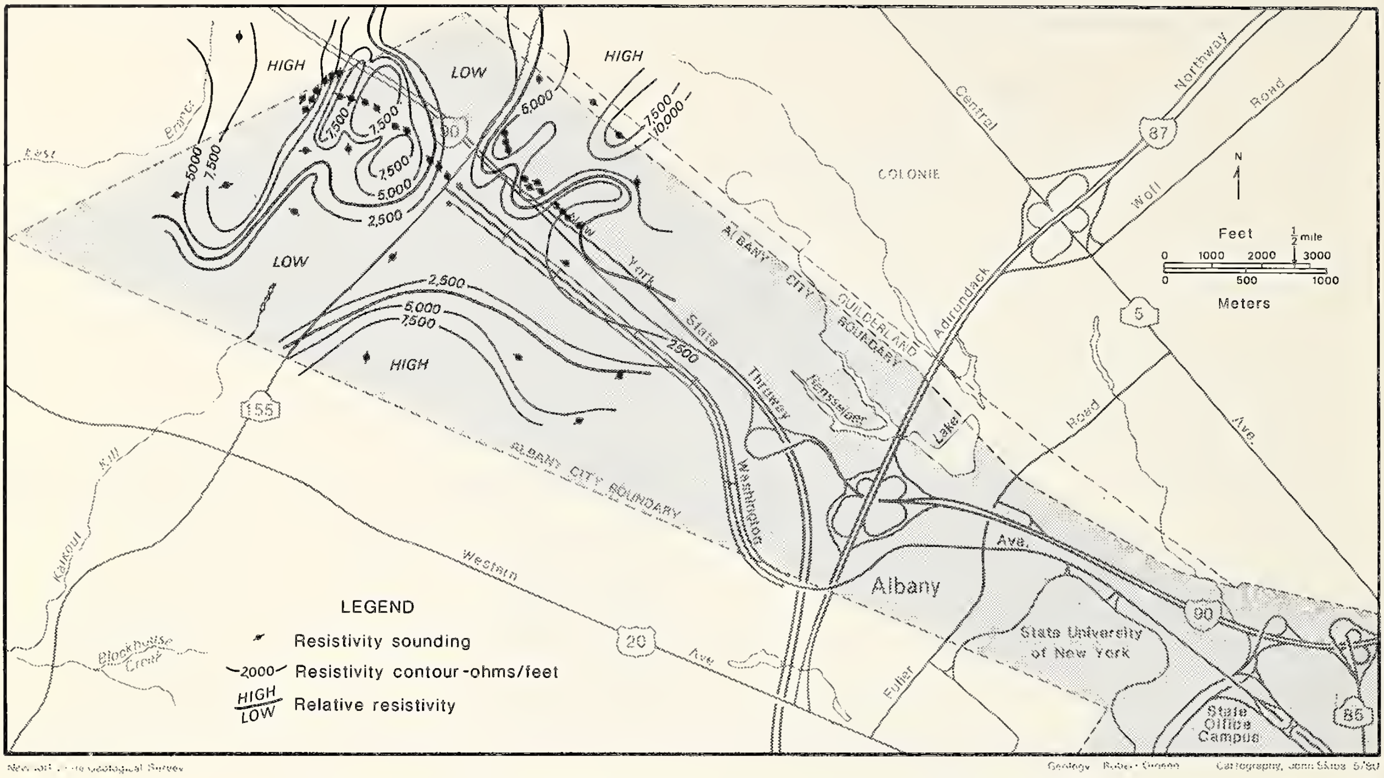

FIGURE 2A. ISO-RESISTIVITIES FOR THE 15-FOOT A-SPACING

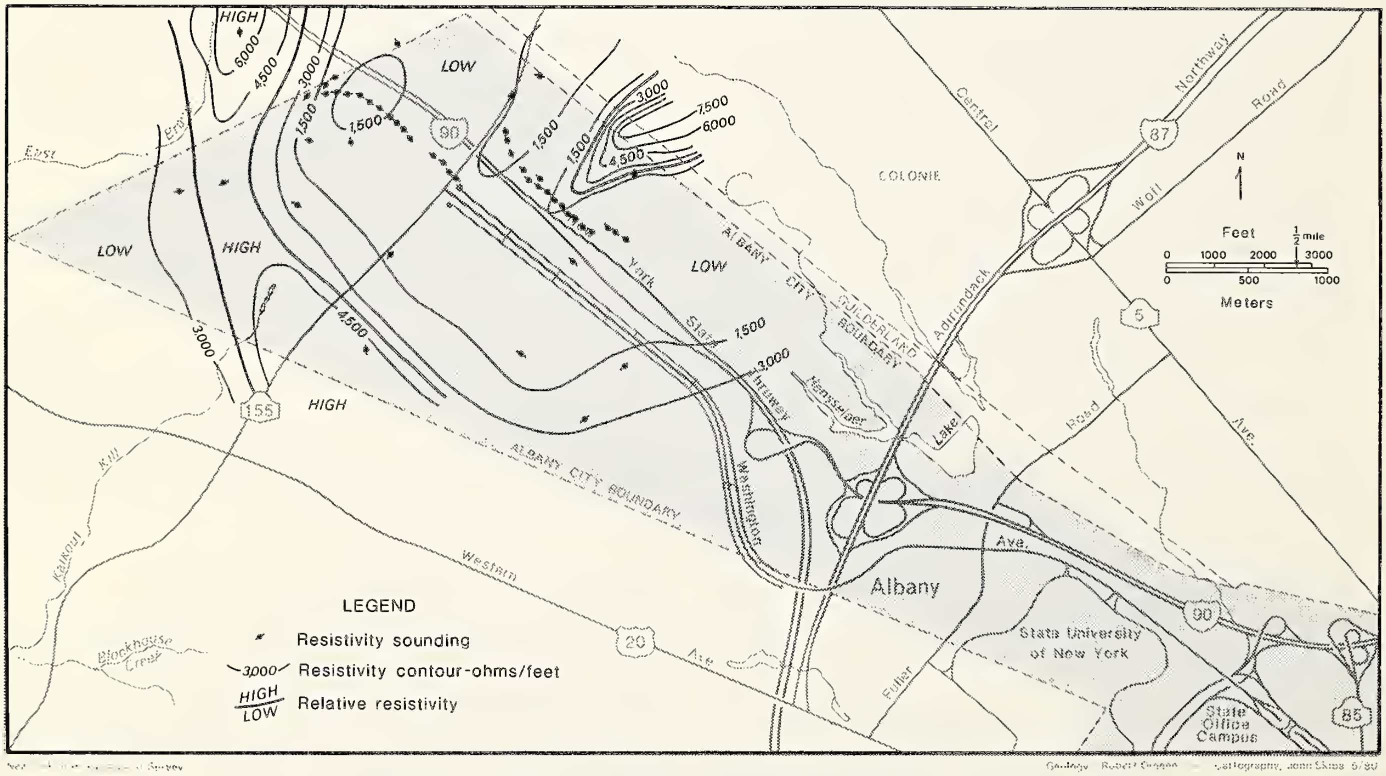

FIGURE 2B. ISO-RESISTIVITIES FOR THE 30-FOOT A-SPACING

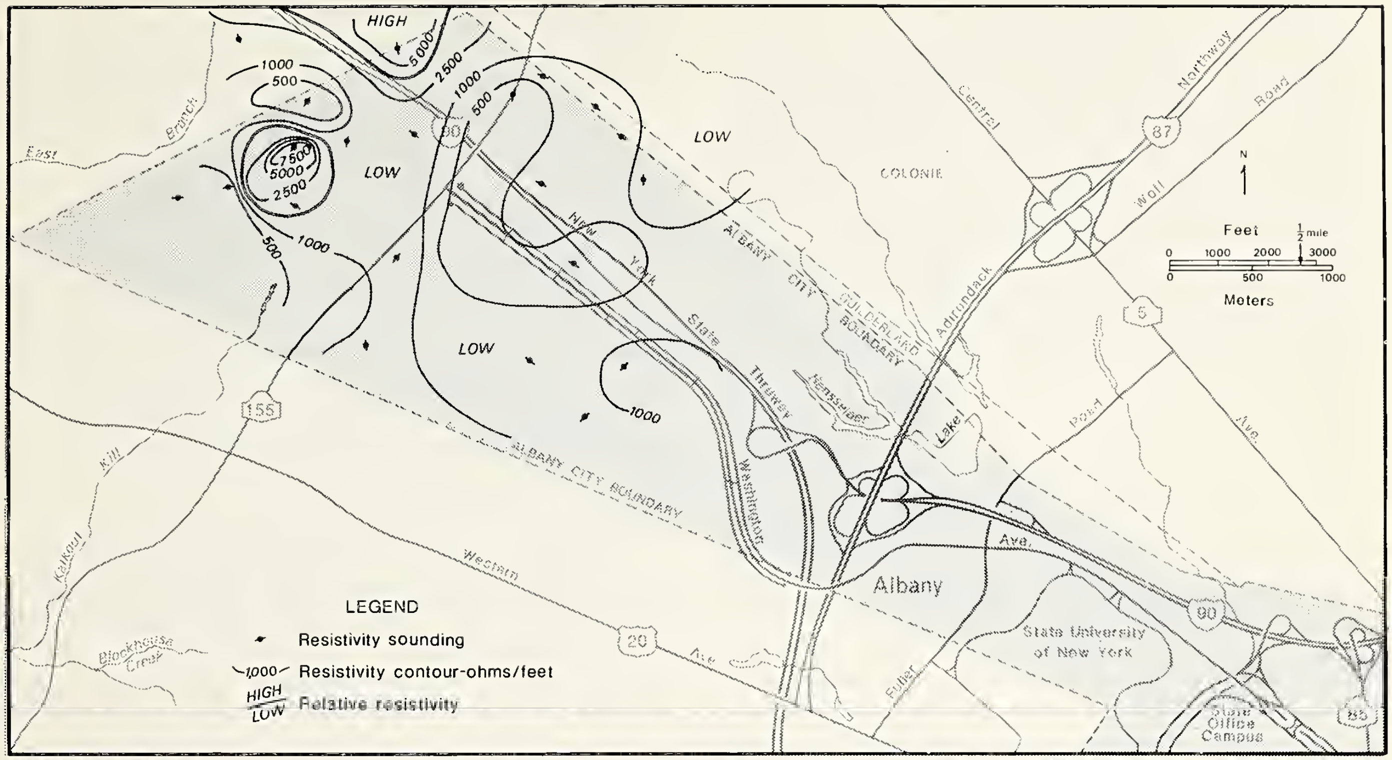

FIGURE 2C. ISO-RESISTIVITIES FOR THE 60-FOOT A-SPACING

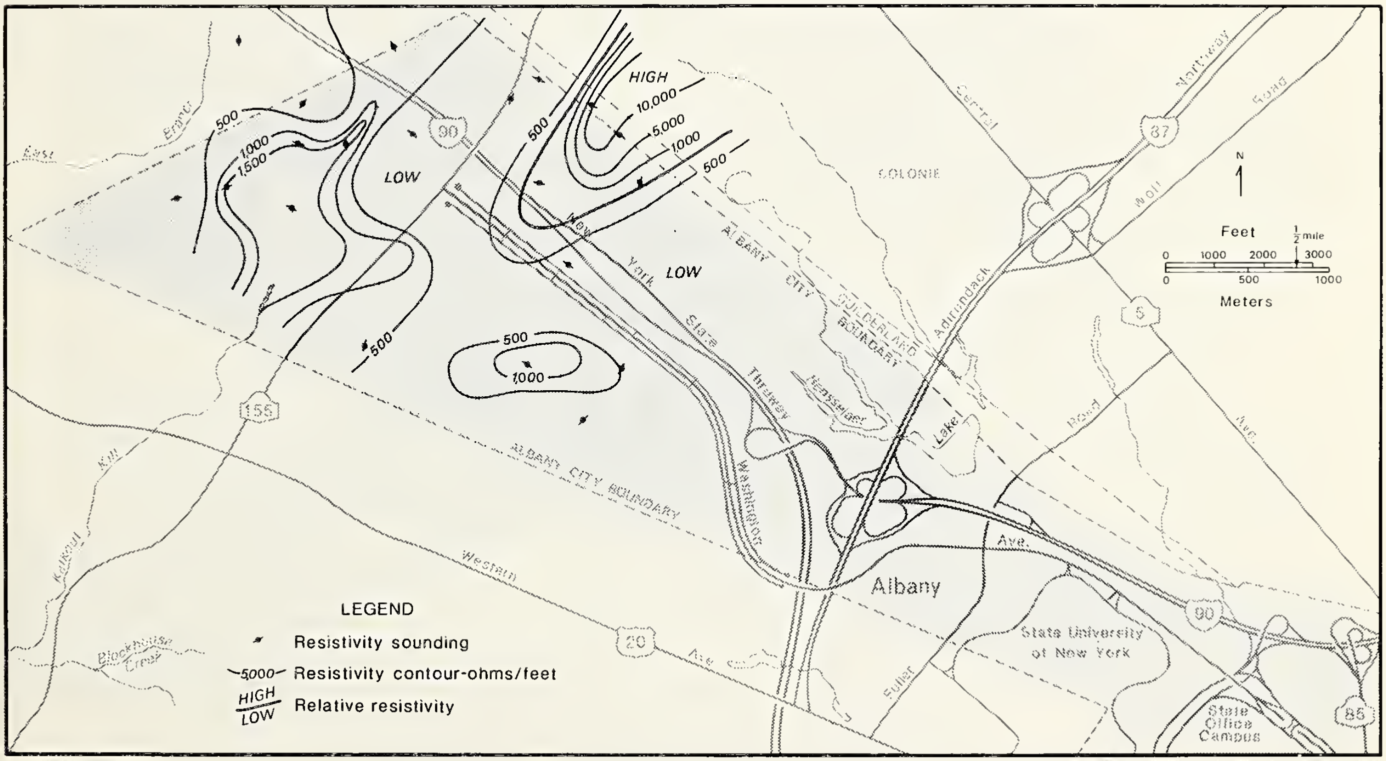

FIGURE 2D. ISO-RESISTIVITIES FOR THE 90-FOOT A-SPACING

BEDROCK TOPOGRAPHY

Thickness of the glacial deposits depends on the depth and configuration of the sedimentary basin, which is governed by the pre-existing bedrock topography. The eastern section of the Pine Bush overlies the western wall of the Colonie Channel and the northern wall of the Mohawk Channel (Fig. 3). The buried bedrock surface has over 300 feet of relief, and the surface with the highest gradient is toward the Mohawk Channel. The gradient eastward, towards the Colonie Channel, is gentler. A bedrock terrace underlies the Pine Bush. The terrace lies at elevations from 275 to 300 ft ASL (Above Sea Level) and is cut by a tributary to the Mohawk Channel at its western side and by another Mohawk tributary along its southeastern portion. The bedrock valleys acted as sedimentary basins that received thick accumulations of glacial sediment; the glacial sediments are thin on the bedrock terrace (Dineen and Rogers, 1979).

GLACIAL GEOLOGY

The distribution of the glacial deposits of the eastern Pine Bush is shown on Figures 4 and 5. Most of the glacial deposits are wedge-shaped masses that are draped against the bedrock terrace.

Glacial Till

Glacially deposited, compact, unsorted boulder clay is called glacial till. Till is thickest in the preglacial valleys (Fig. 4) and is thin-to-absent elsewhere (QT on Fig. 5). Till becomes thicker towards the northeast in the vicinity of a drumlin field just north of the intersection of N.Y. Rts. 5 and 155 (Dineen, 1975).

Ice-Contact Sand and Gravel

Ice-contact sand and gravel was deposited by meltwater in contact with the glacier. Ice-contact sand and gravel (QI on Figs. 4 and 5) is stratified. The sand

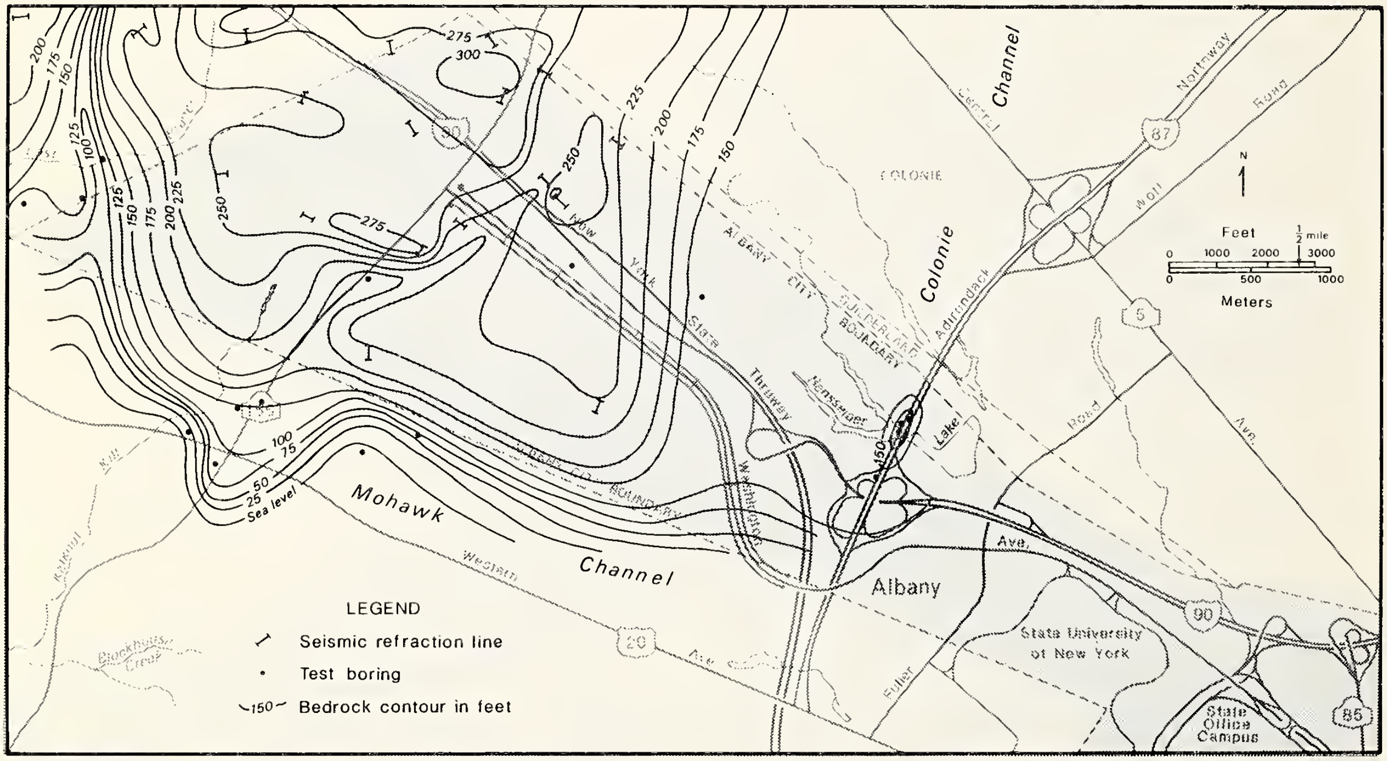

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FIGURE 3. BEDROCK TOPOGRAPHY

and gravel partially fill the small tributary valleys that are cut into the bedrock terrace. The sand and gravel is a relatively thin unit and grades vertically and laterally into the basal Lake Albany Silt and Clay.

Lake Albany Silt and Clay

Very-fine-grained glacier-lacustrine silt and clay are mapped as Lake Albany silt and clay. The upper section of the silt and clay is exposed in the deeply incised valleys of the Kaikout Kill and Patroon Creek (QLAC on Fig. 5). The silt and clay grades downward to the fine-grained, upper part of the ice-contact sand and gravel and grades upward and laterally to silty sand and sand. The silt and clay rarely extend above an elevation of 260 ft ASL, and they pinch out against the bedrock terrace, causing a "drape effect" on the underlying bedrock (Fig. 4A). The silt and clay are highest over the bedrock terrace and lowest over the preglacial channels and are draped downward away from the bedrock terrace. This draping might be due to post-depositional compaction. Some wedges and lenses of silty sand and sand occur within the silt and clay unit (Fig. 4).

Lake Albany Silty Sand

The Lake Albany silty sand contains 10 to 50 percent silt, grades downward into silt and clay, and grades upward and eastward into sand. The silty sand (QLAM on Fig. 5) thickens towards the south and southeast, pinches out towards the east and is dominant above an elevation of 200 ft ASL (Fig. 4). The top of the silty sand is also draped over the bedrock terrace. Several elongate depressions or valleys occur in the upper surface of the silty sand and a fining-upward sequence of gravel-sand-silt occurs in these depressions.

Lake Albany Sand

Lake Albany Sand (QLAS on Fig. 5) is a fine- to medium-grained sand and contains thin laminae of silt; the sand grades downward and westward into silty sand, and is overlain by dune sand (Fig. 4). The lake sand can be differentiated from dune sand by the vertical change from horizontal and ripple-laminated lake sand to dune sand with thick, high-angle (>30°) foreset beds. The lake sand thickens towards the east.

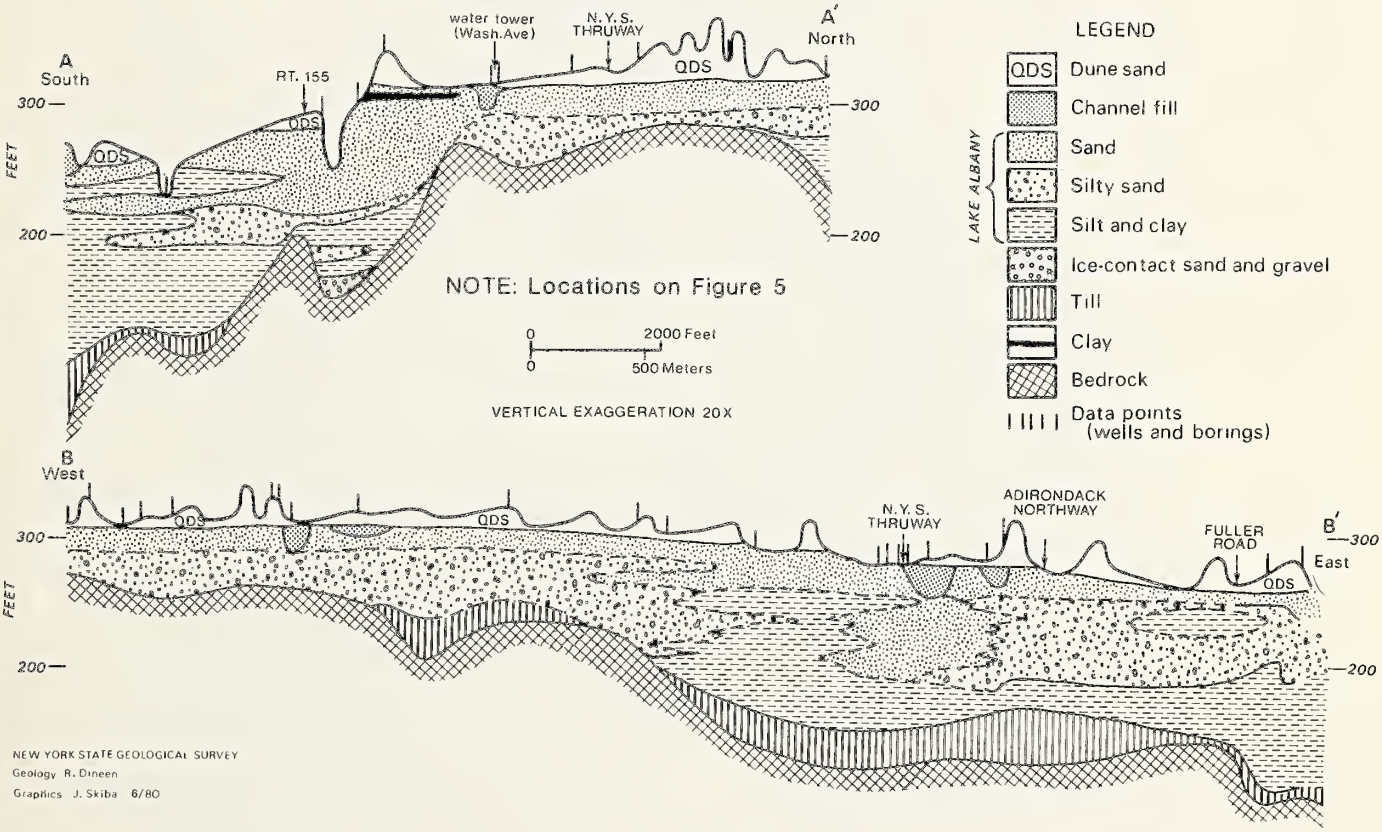

FIGURE 4. CROSS SECTIONS: PINE BUSH AQUIFER

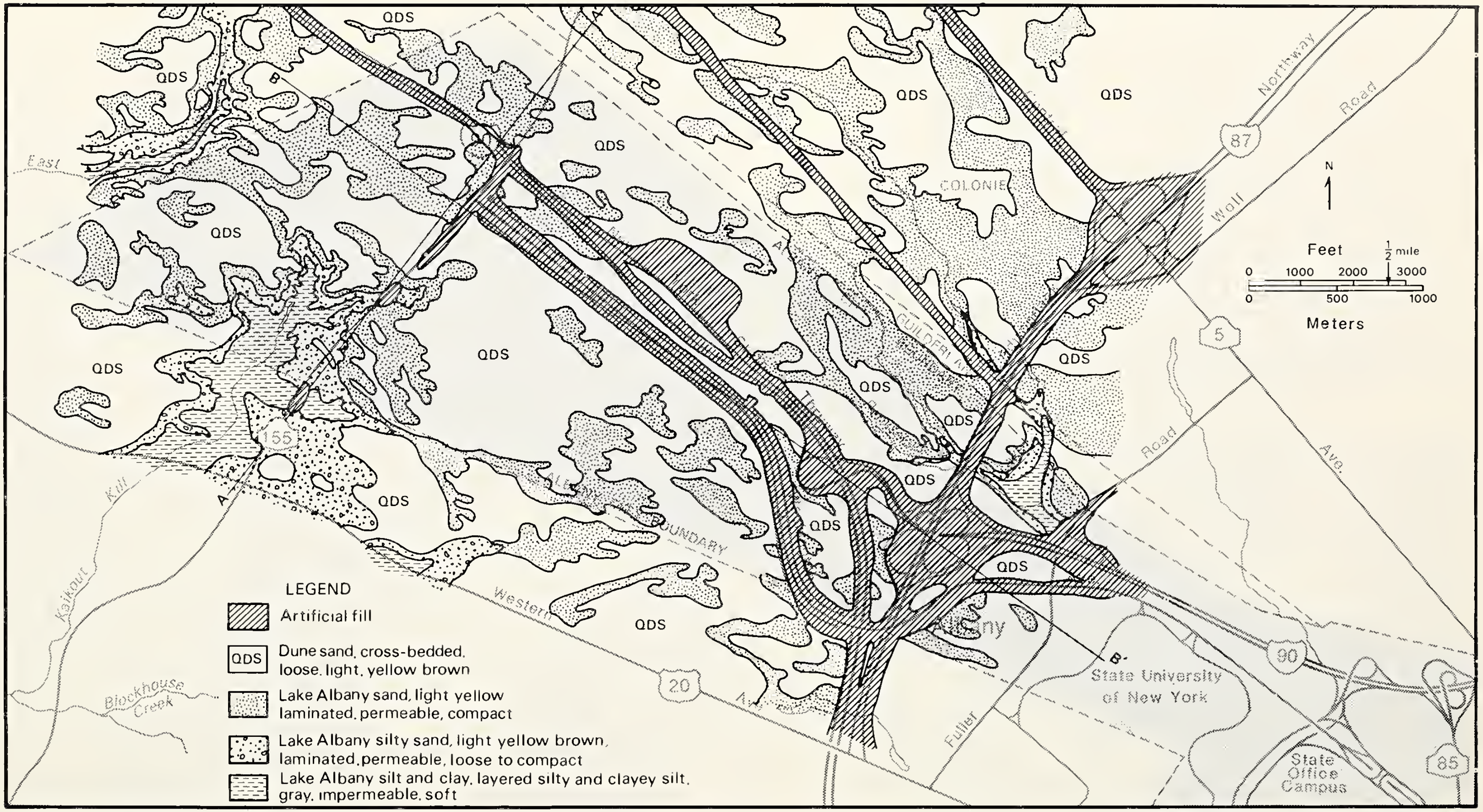
LEGEND
Artificial fill
QDS Dune sand, cross-bedded, loose, light, yellow brown
Lake Albany sand, light yellow laminated, permeable, compact
Lake Albany silty sand, light yellow brown, laminated, permeable, loose to compact
Lake Albany silt and clay, layered silty and clayey silt, gray, impermeable, soft
QDS
COLONIE
GUILDERLAND
ALBANY
BOUNDARY
Albany
State University of New York
State Office Campus
Northway
Wolf Road
Road
Ave.
Fuller
Western Ave.
East
Kill
Kaikout
Blockhouse Creek
87
5
90
85
20
155
A
A'
B
B'
N
Feet
0
1000
2000
3000
1/2 mile
0
500
1000
Meters

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FIGURE 5. SURFICIAL GEOLOGY

Lake Albany 300-foot Clay

The 1- to 2-m (3- to 6-foot) thick 300-foot clay layer is within the upper section of the lake sand (unit QLAV, Fig. 5). The 300-foot clay has a distinct upper contact, which slopes downward towards the south and east (Fig. 4). Several 70- to 160-m (200- to 500-ft) gaps appear in this clay, which coincide with the depressions or valleys in the surface of the underlying silty sand, and allow recharge to the lower units (Fig. 6C). A possible continuation of the clay layer occurs to the southeast of the main unit.

Dune Sand

Dune sand is cross-bedded. Its lower contact is a thin, shale-granule lag-concentrate that overlies the lake sand. The dunes, between 2 and 16 m (5 and 50 ft) high, are a discontinuous, irregular mantle over the lake sand.

INTERPRETATIONS AND CONCLUSIONS

Geophysics

Bedrock: The lower resistivities of the 90-foot A-Spacing (Fig. 2D) are caused by the underlying shale bedrock (Table 2). Seismic velocities for bedrock range between 9,960 ft/sec and 19,250 ft/sec (Fig. 1D). Most of the bedrock velocities are between 13,000 ft/sec and 17,000 ft/sec, which is the range expected from graywacke and shale in the Hudson Valley.

Till: Thick till is inferred to exist at the northeast resistivity high (Fig. 2D). This is based on the high resisitivity of 10,000 Ω/ft, the 7,000 ft/sec seismic layer in seismic line 79-6s, and outcrops of drumlins in the vicinity of N.Y. Rts. 5 and 155.

Lake Sediments: The 30-foot and 60-foot A-Spacings are similar in that they do not show large resistivity contrasts. There is, however, an arc of relatively high resistivity from northwest to southeast (Figs. 2B and 2C). The V_2 seismic velocities along the arc show high velocities (Fig. 1C). The arc is underlain by the 300-foot clay and by silty sand (Figs. 4, 5). The silty sand might be over-compacted by either beach waves or a readvance of the glacier, resulting in a high seismic velocity. Dry sand underlies the areas of high resistivities recorded at the 15-foot A-Spacing. Lower resistivities on Figure 2A might be due to wet silty sand. The dry sand has seismic velocities between 80 and 2,000 ft/sec.

Glacial Geology

Glacial sediments described in this study were deposited between approximately 15,000 and 13,000 years B.P. within 80 km (50 miles) of the margin of the retreating Hudson Valley Glacial Lobe of the Woodfordian Ice Sheet (Dineen and Rogers, 1979). Till was deposited directly beneath and on the glacier. Ice-contact sand and gravel and the lower part of the Lake Albany silt and clay were deposited in 50m (150 feet) deep water of Glacial Lake Albany between 0.8 and 3.2 km (0.5 to 2 miles) of the retreating glacial terminus, at a time when the water elevation of Lake Albany was at 340 feet (Dineen and Rogers, 1979, Dineen and Hanson, in prep.). The silty sand was deposited in water that was 15 m (50 feet) deep during successively lower water levels of Lake Albany.

Lake Albany was probably less than 10 m (30 feet) deep during its 310-foot stage (Figs. 7A and 7D). Thick wedges of lake sand were deposited offshore along the sand bar system (Figs. 4 and 7A). This created a lagoon where varved clay was deposited. Silty sand was deposited offshore of the sand bar system.

With a decrease of the lake level to 270 feet, wind and streams began to erode the exposed shore and sand plain sediments and the construction of large sand dunes began (Fig. 7B and 7D). Streams eroded valleys through the 300-foot varved clay, carrying sand to the near-shore zone of the lake, while additional varved clay was deposited in deeper offshore water (Fig. 4 and 6C).

The exposed sand plain increased in width as the lake level continued to fall to 250 feet (Fig. 7C and 7D). Wave action formed a beach along the southern shore and large streams cut into the exposed lake floor. The dune building continued until approximately 5,000 years ago (Dineen, Rogers, Buyce, 1978).

Pine Bush Aquifer

The Pine Bush aquifer is composed of the silty sand, lake sand, and dune sand geologic units. These sands are widespread, thick, and permeable (Figs. 4 and 5). Recharge of the aquifer occurs near the ground water divide at Rt. 155 and the Washington Ave. Extension. Ground water drains westward into the Hunger Kill, southward into the Kaikout Kill, and eastward into Patroon Creek. Silt and clay and the +300-ft varved clay are aquicludes that underlie the aquifer; they impede the vertical movement of water. Ground water generally migrates downward along the top of the silt and clay (Fig. 6A) until it enters a stream valley. The +300-ft clay causes perched water tables (Fig. 6C).

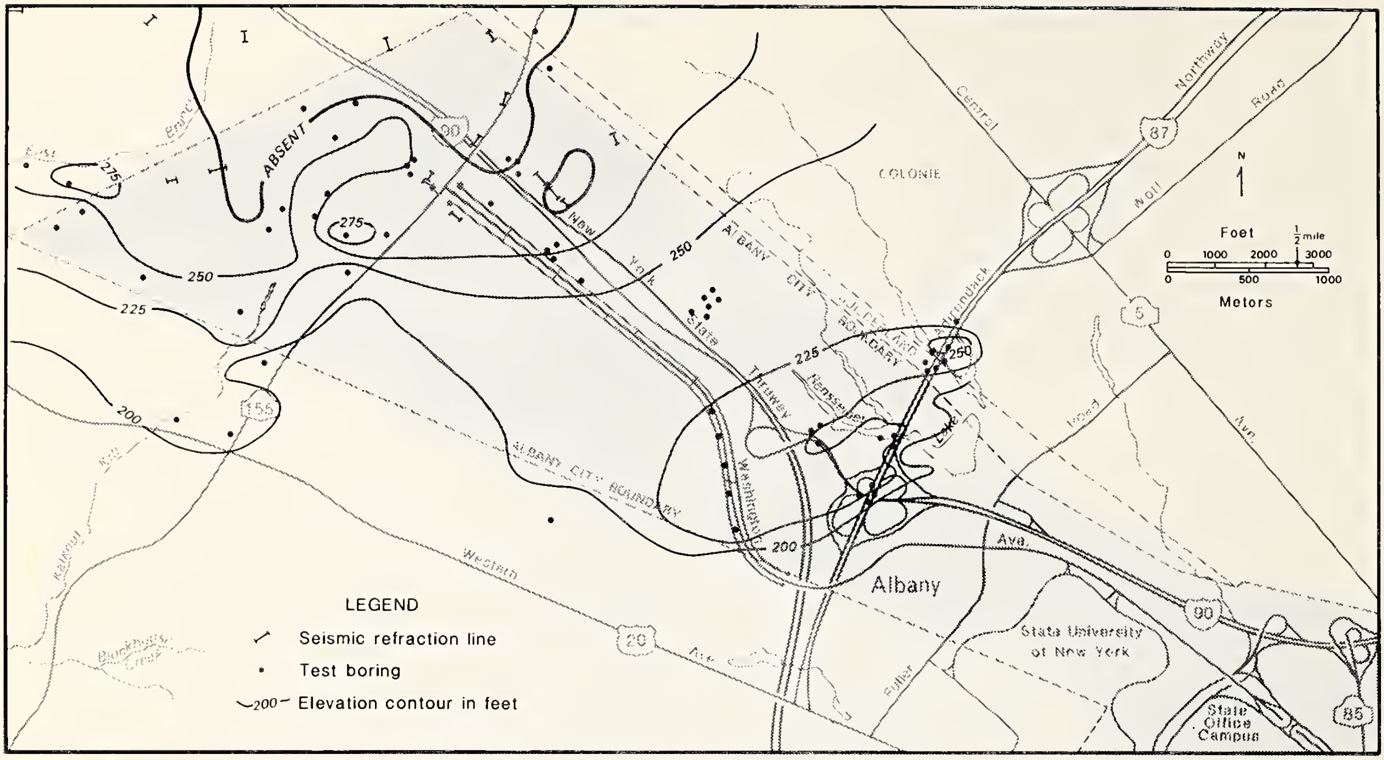

FIGURE 6A. TOP ELEVATIONS OF LAKE ALBANY SILT AND CLAY

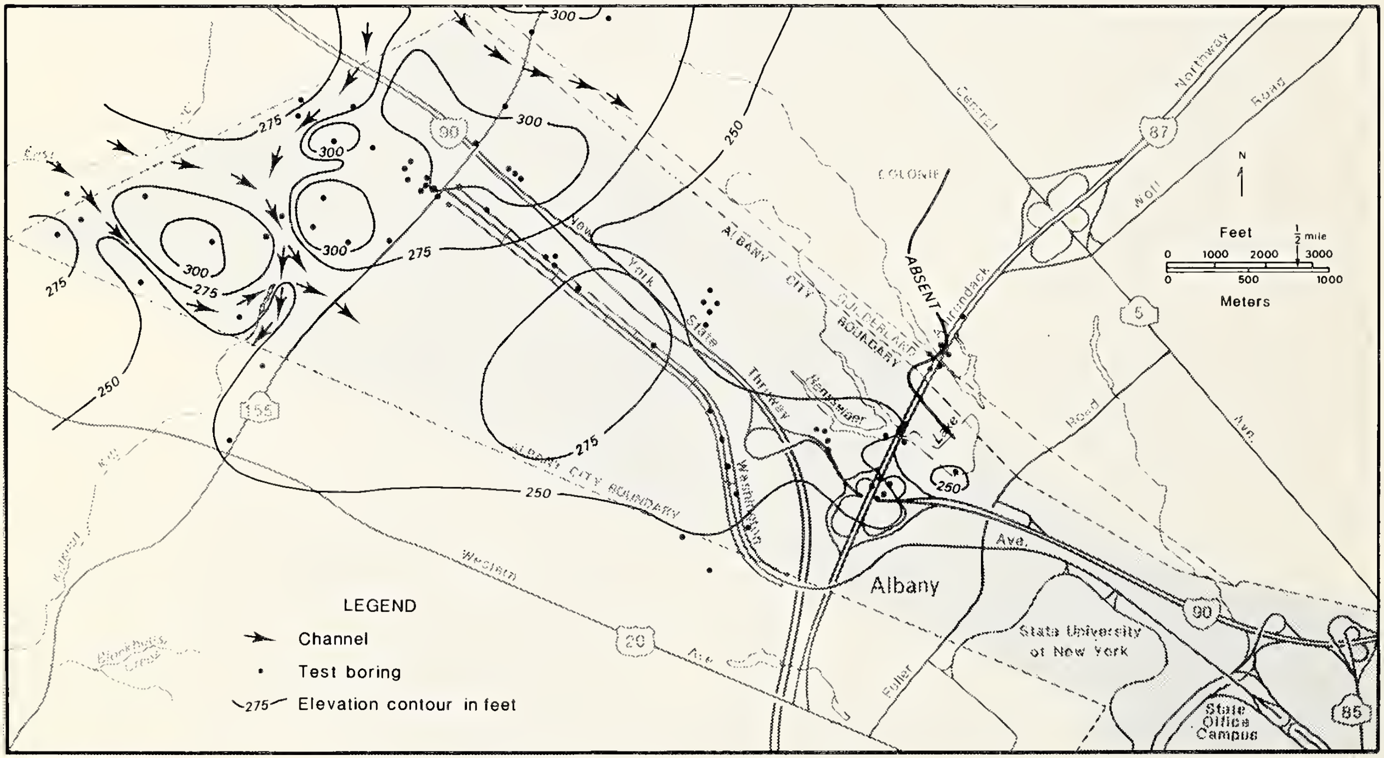

FIGURE 6B. TOP ELEVATIONS OF LAKE ALBANY +300-FOOT CLAY

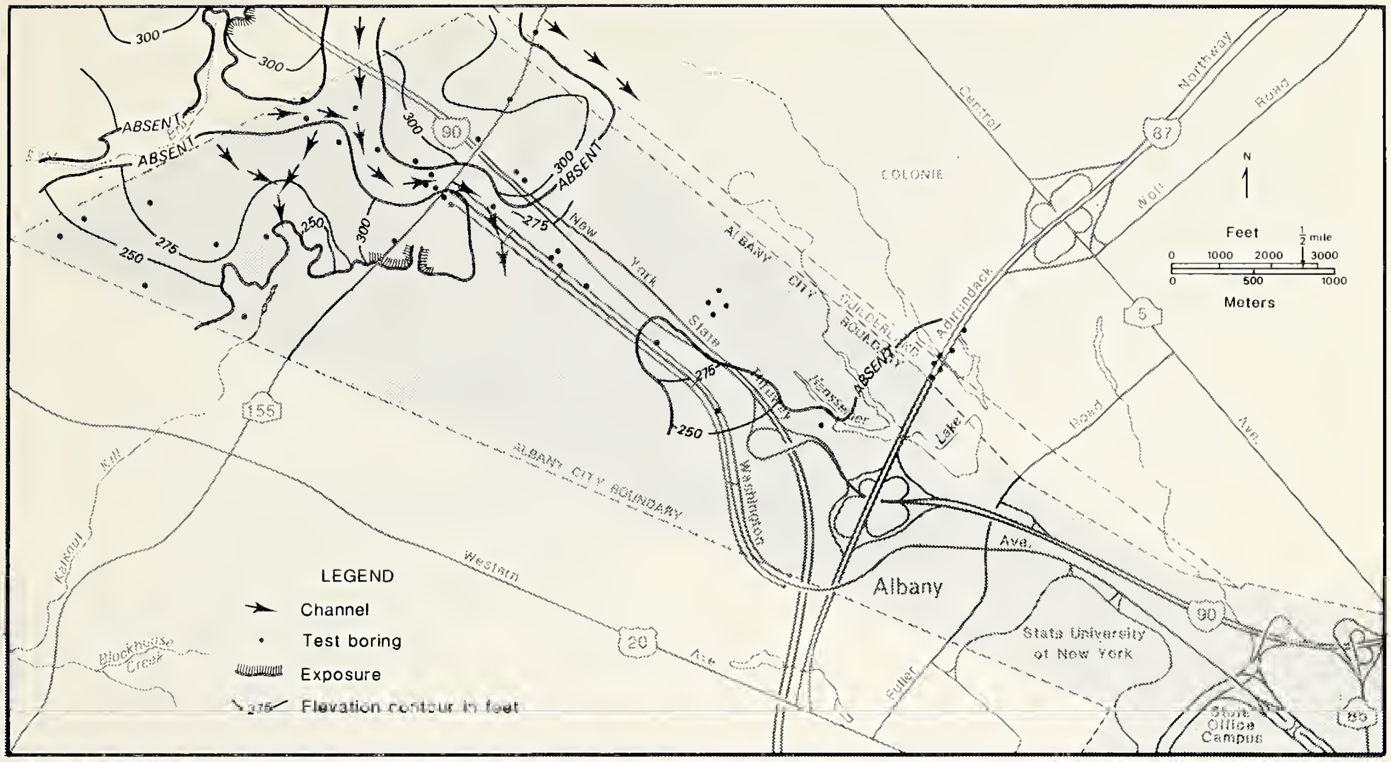

FIGURE 6C. TOP ELEVATIONS OF LAKE ALBANY SILTY SAND

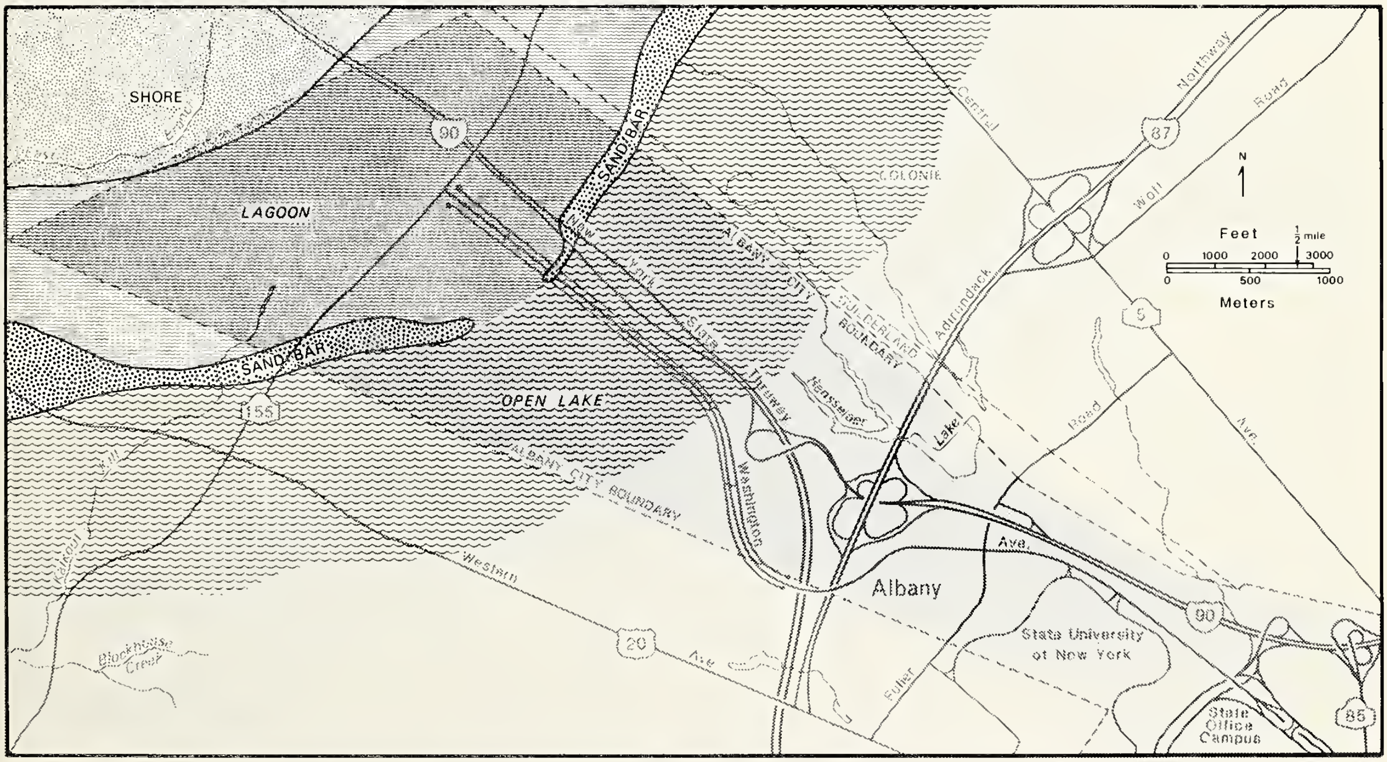

FIGURE 7A. DEPOSITIONAL ENVIRONMENTS OF +310 - FOOT LAKE ALBANY

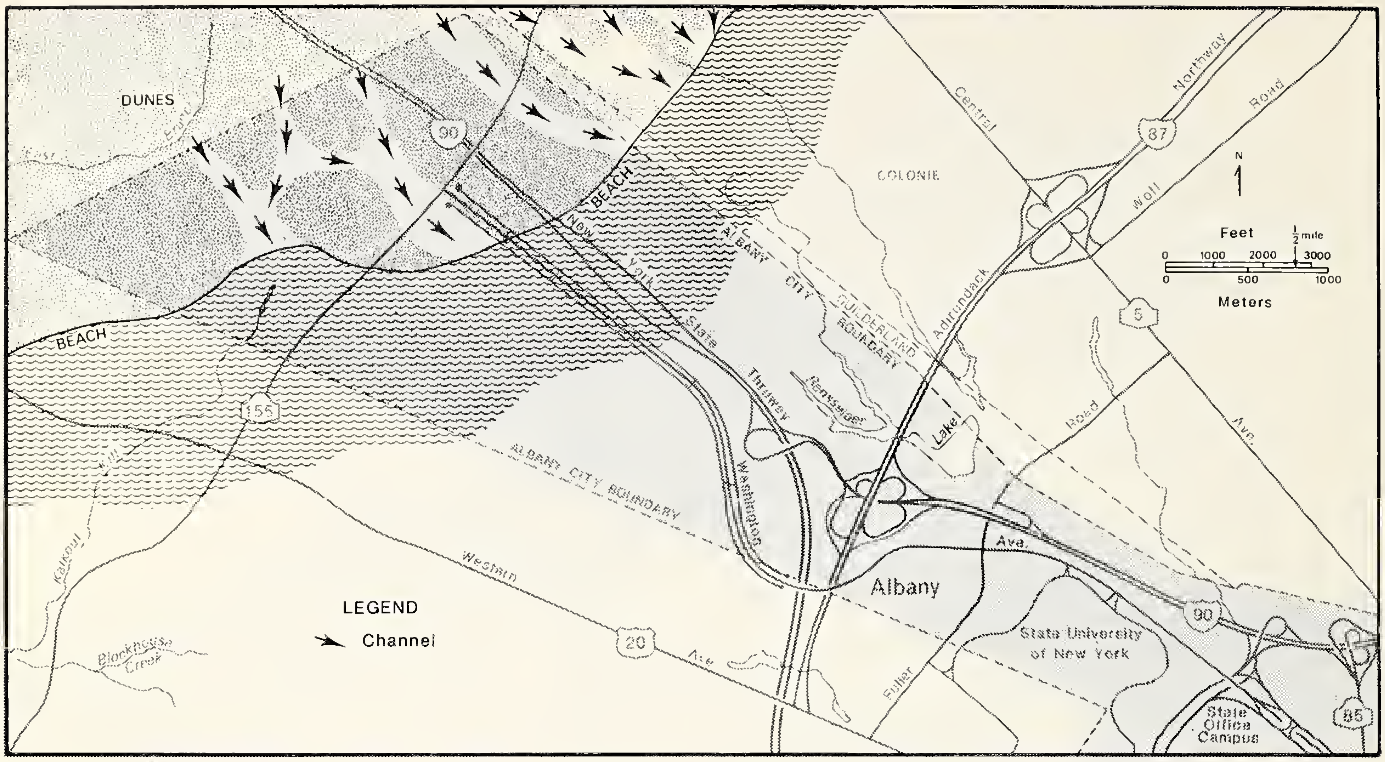

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FIGURE 7 B. DEPOSITIONAL ENVIRONMENTS OF THE +270-FOOT LAKE ALBANY

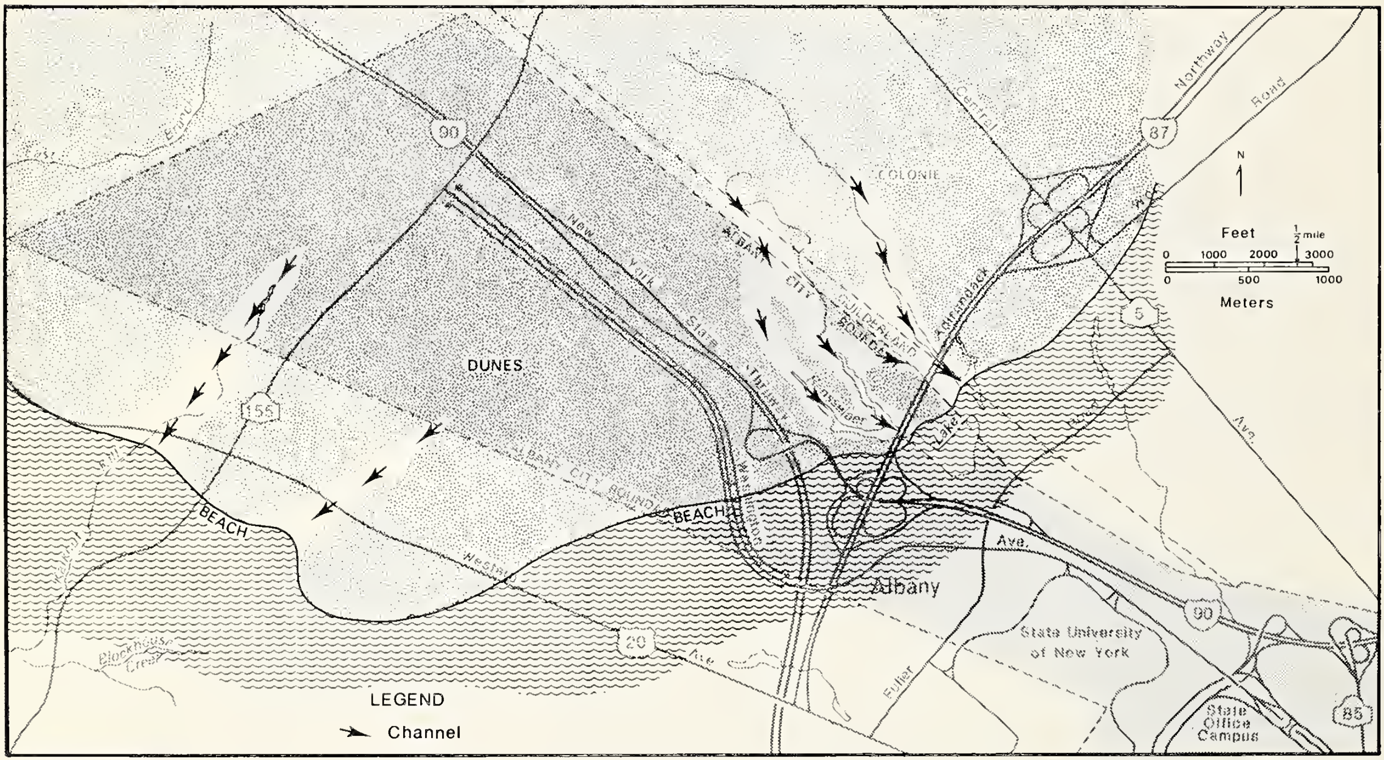

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FIGURE 7C. DEPOSITIONAL ENVIRONMENTS OF THE +250-FOOT LAKE QUAKER SPRINGS

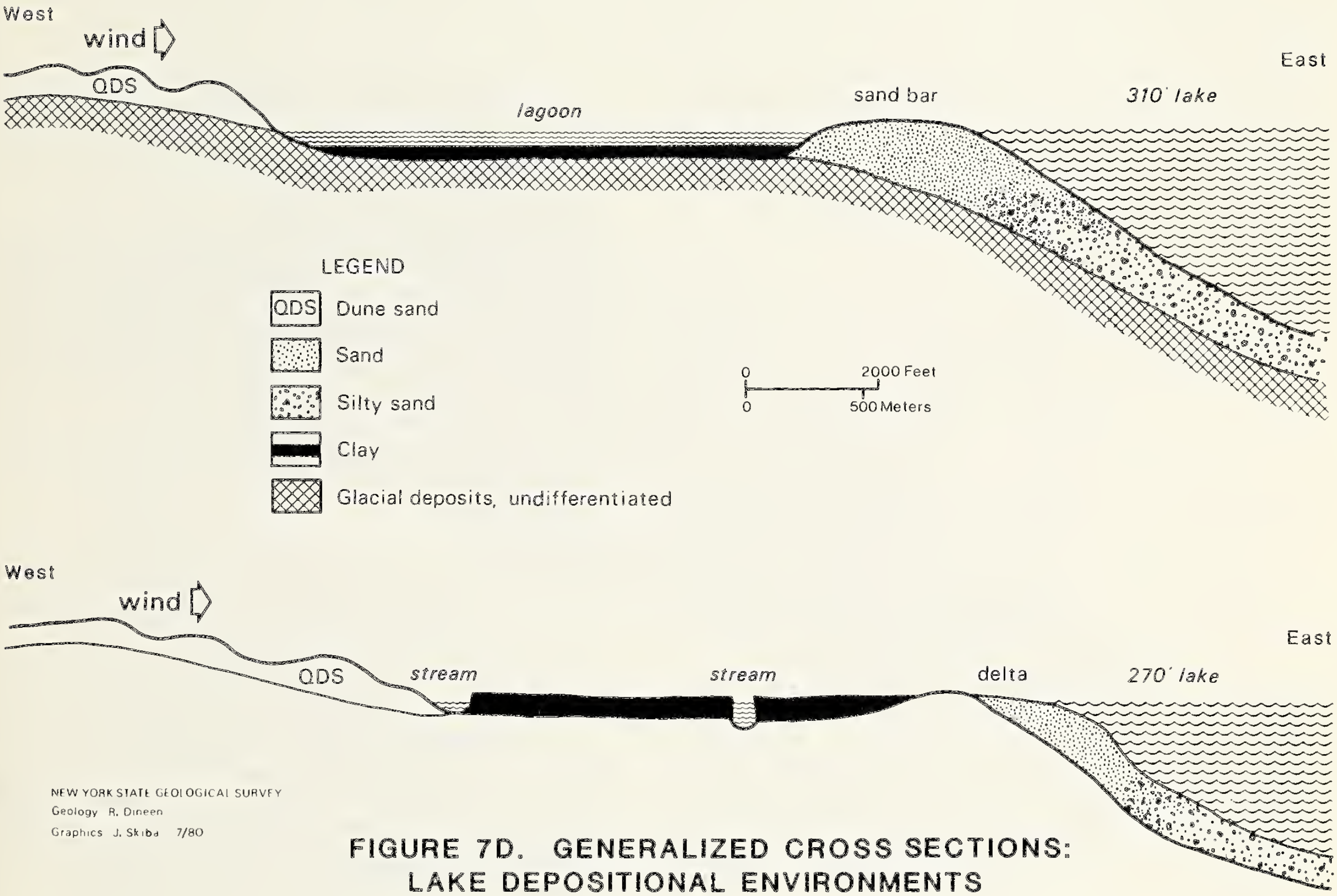

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FIGURE 7D. GENERALIZED CROSS SECTIONS: LAKE DEPOSITIONAL ENVIRONMENTS

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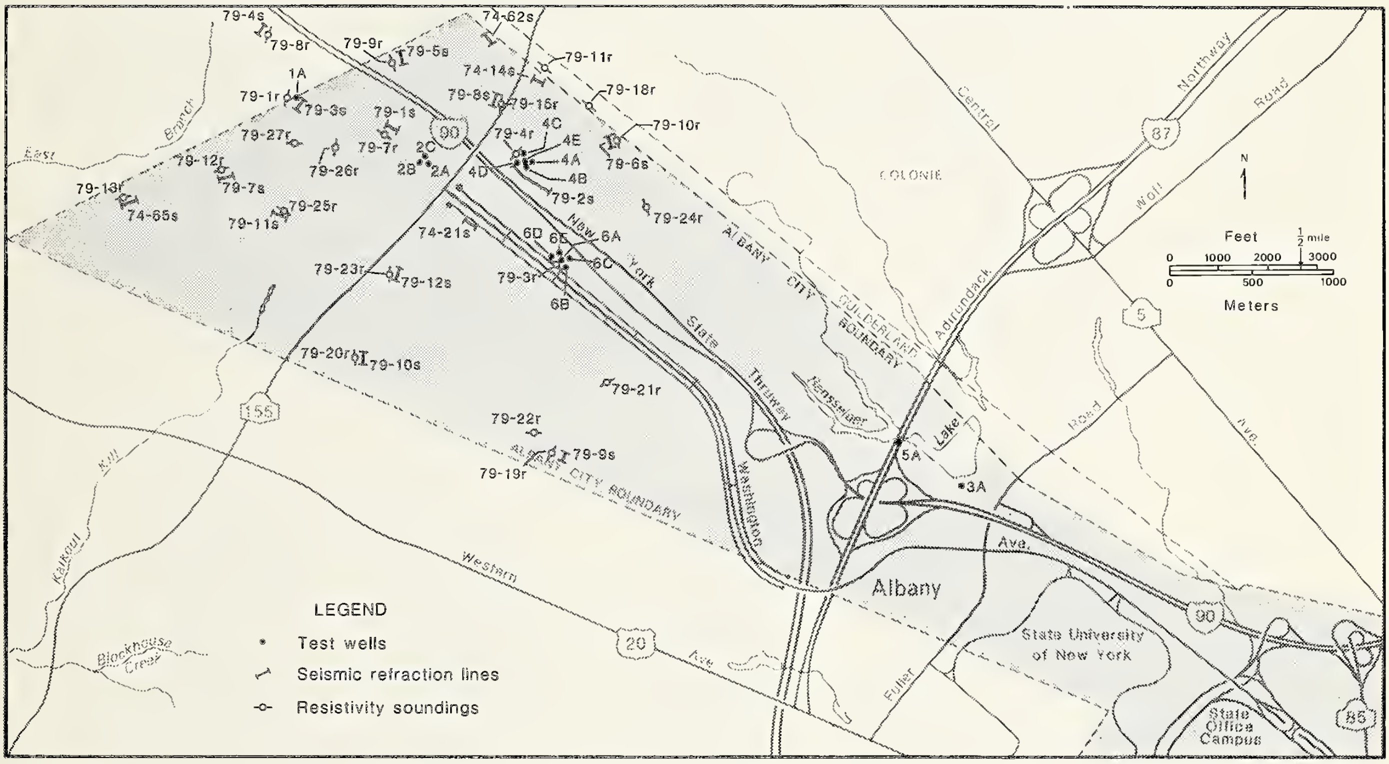

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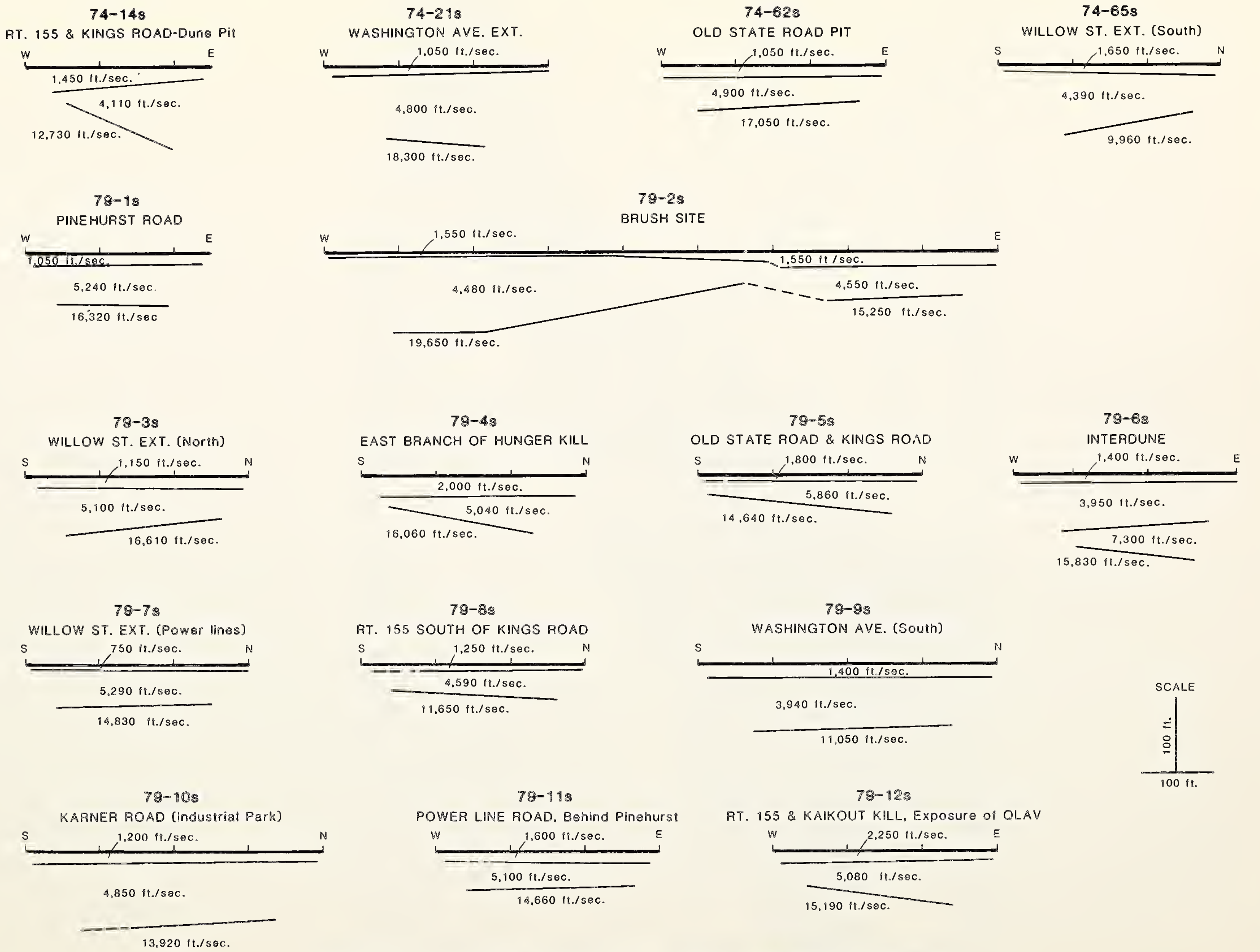
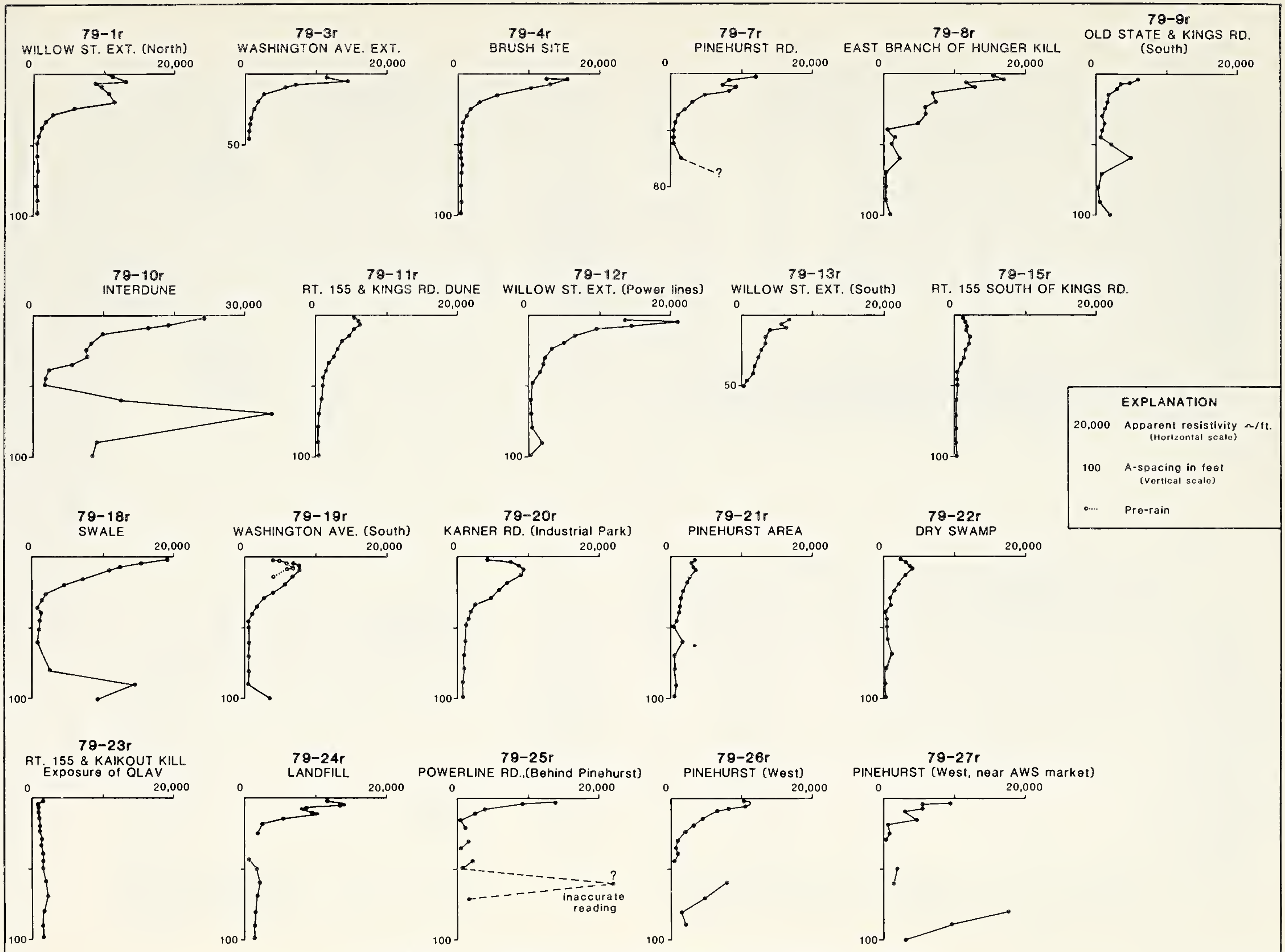
APPENDIX 1. LOCATION OF TEST SITES, PINE BUSH AQUIFER



APPENDIX 2. SEISMIC REFRACTION LINES, PINE BUSH AQUIFER
(See appendix 1 for locations)

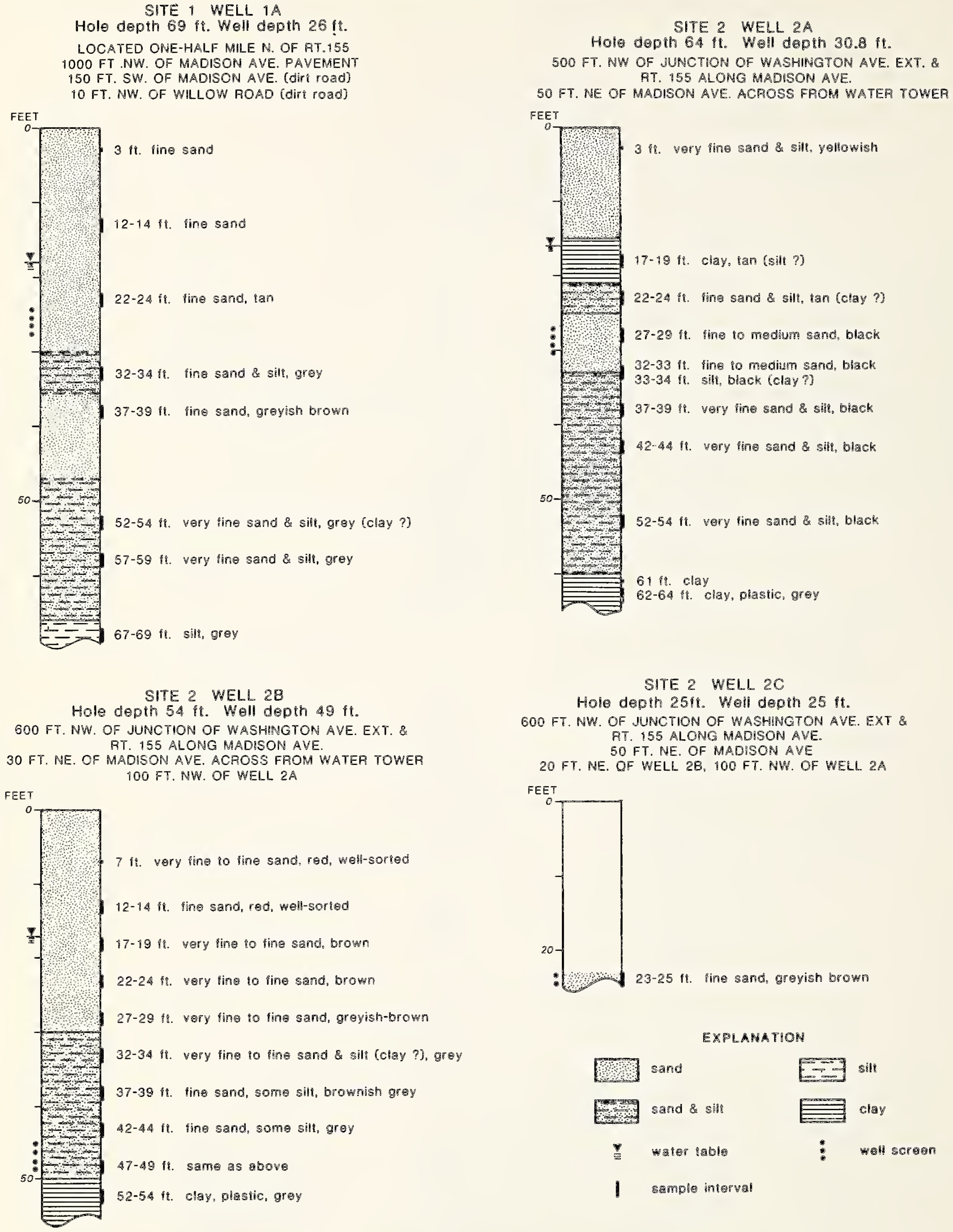
NEW YORK STATE GEOLOGICAL SURVEY
Seismicity R. Dineen Graphics J. Skiba 10/80



APPENDIX 3. RESISTIVITY SOUNDINGS, PINE BUSH AQUIFER

(See appendix 1 for locations)

NEW YORK STATE GEOLOGICAL SURVEY
Resistivity, R. Dineen Graphics, J. Skiba 11/80



SITE 1 WELL 1A
Hole depth 69 ft. Well depth 26 ft.
LOCATED ONE-HALF MILE N. OF RT.155
1000 FT .NW. OF MADISON AVE. PAVEMENT
150 FT. SW. OF MADISON AVE. (dirt road)
10 FT. NW. OF WILLOW ROAD (dirt road)

FEET
0
50
3 ft. fine sand
12-14 ft. fine sand
22-24 ft. fine sand, tan
32-34 ft. fine sand & silt, grey
37-39 ft. fine sand, greyish brown
52-54 ft. very fine sand & silt, grey (clay ?)
57-59 ft. very fine sand & silt, grey
67-69 ft. silt, grey

SITE 2 WELL 2A
Hole depth 64 ft. Well depth 30.8 ft.
500 FT. NW OF JUNCTION OF WASHINGTON AVE. EXT. &
RT. 155 ALONG MADISON AVE.
50 FT. NE OF MADISON AVE. ACROSS FROM WATER TOWER

FEET
0
50
3 ft. very fine sand & silt, yellowish
17-19 ft. clay, tan (silt ?)
22-24 ft. fine sand & silt, tan (clay ?)
27-29 ft. fine to medium sand, black
32-33 ft. fine to medium sand, black
33-34 ft. silt, black (clay ?)
37-39 ft. very fine sand & silt, black
42-44 ft. very fine sand & silt, black
52-54 ft. very fine sand & silt, black
61 ft. clay
62-64 ft. clay, plastic, grey

SITE 2 WELL 2B
Hole depth 54 ft. Well depth 49 ft.
600 FT. NW. OF JUNCTION OF WASHINGTON AVE. EXT. &
RT. 155 ALONG MADISON AVE.
30 FT. NE. OF MADISON AVE. ACROSS FROM WATER TOWER
100 FT. NW. OF WELL 2A

FEET
0
50
7 ft. very fine to fine sand, red, well-sorted
12-14 ft. fine sand, red, well-sorted
17-19 ft. very fine to fine sand, brown
22-24 ft. very fine to fine sand, brown
27-29 ft. very fine to fine sand, greyish-brown
32-34 ft. very fine to fine sand & silt (clay ?), grey
37-39 ft. fine sand, some silt, brownish grey
42-44 ft. fine sand, some silt, grey
47-49 ft. same as above
52-54 ft. clay, plastic, grey

SITE 2 WELL 2C
Hole depth 25ft. Well depth 25 ft.
600 FT. NW. OF JUNCTION OF WASHINGTON AVE. EXT &
RT. 155 ALONG MADISON AVE.
50 FT. NE. OF MADISON AVE
20 FT. NE. OF WELL 2B, 100 FT. NW. OF WELL 2A

EXPLANATION

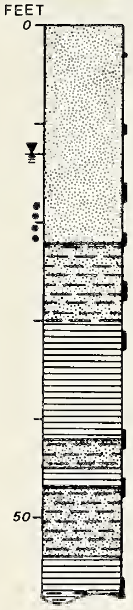
APPENDIX 4. TEST WELL LOGS, PINE BUSH AQUIFER (1 of 5)

(See appendix 1 for locations)

NEW YORK STATE GEOLOGICAL SURVEY Geology, U.S.G.S. Graphics, J. Skiba 11/80

SITE 3 WELL 3A
Hole depth 58 ft. Well depth 22 ft.

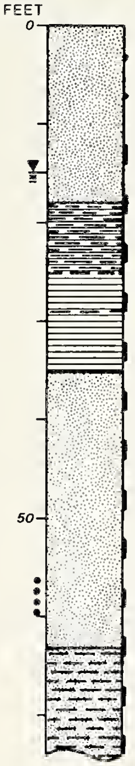
1000 FT. NW. OF FULLER ROAD ALONG DIRT/BLACKTOP ROAD
40 FT. W. OF BLACKTOP ROAD
W. OF RENSSELAER LAKE AT GATE TO SIX MILE WATERWORKS



3 ft. very fine to fine sand, dark brown
10-11 ft. fine sand, reddish tan
16-18 ft. fine sand, reddish tan
21-23 ft. very fine to fine sand & silt, tan
26-28 ft. very fine sand, silt, clay, tan
31-33 ft. clay, tan to 32.5 ft. then bluish grey
41-42 ft. clay, bluish grey
42-43 ft. very fine sand & silt, tan
46-47 ft. clay, bluish grey
47-48 ft. very fine sand & silt, grey
56-57 ft. clay, light brown
57-58 ft. silt & clay, dark brown

SITE 4 WELL 4A
Hole depth 74 ft. Well depth 60 ft.

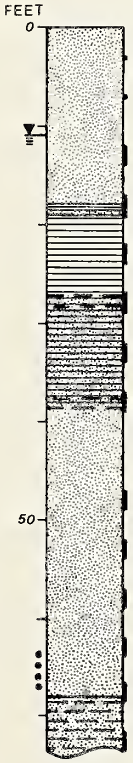
300 FT. NE. OF THRUWAY UNDERPASS ALONG RT. 155 EAST
1000 FT. SE. OF RT. 155 ALONG DIRT ROAD ON N. SIDE OF ROAD



3 ft. very fine sand, reddish tan
7 ft. same as above
12-14 ft. same as above
same as above to 17.5 ft., 17.5-19 ft. silt & clay, red
22-23 ft. silt & clay, reddish tan
23-24 ft. silt & clay, grey
27-28.9 ft. clay, grey
28.9-29 ft. silt & clay, grey
32-34 ft. clay, grey
37-39 ft. fine sand, reddish tan
42-44 ft. very fine to fine sand, reddish tan
47-49 ft. fine sand, brown
52-54 ft. fine sand, reddish brown
57-59 ft. fine sand, reddish brown
62-63 ft. same as above
63-64 ft. very fine sand & silt, greyish brown
67-69 ft. very fine sand & silt, greyish
72-74 ft. very fine sand & silt, dark grey

SITE 4 WELL 4B
Hole depth 74 ft. Well depth 67.5 ft.

300 FT. NE. OF THRUWAY UNDERPASS ALONG RT. 155 EAST
850 FT. SE. OF RT. 155 ALONG DIRT ROAD ON N. SIDE OF ROAD
150 FT. NW. OF WELL 4A



3 ft. fine sand, reddish brown
7 ft. same as above
12-14 ft. same as above
17-18.2 ft. same as above
18.2-18.5 ft. clay, brown
18.5-18.6 ft. fine to medium sand, brownish grey
18.6-19 ft. clay, grey
22-24 ft. clay, dark grey (varved with brown streaks)
27-27.5 ft. same as above
27.5-28.8 ft. clay, grey, very fine sand & silt
28.8-29 ft. sand, some silt, greyish brown
32-34 ft. clay, gray, some very fine sand, brownish grey
37-38.5 ft. same as above
38.5-38.9 ft. clay, grey, some very fine sand & silt
38.9-39 ft. very fine to fine sand, reddish brown
47-49 ft. very fine sand, grey, some silt
52-54 ft. very fine to fine sand, greyish brown
57-59 ft. fine sand, greyish brown
62-64 ft. same as above
67-68.8 ft. same as above
68.8-69 ft. silt, grey, some sand & clay
72-74 ft. very fine sand, grey, some silt to clay, grey with some fine sand & clay. Material grades finer with depth.

EXPLANATION

▨	sand	▤	clay
▨	sand & silt	▤	silt & clay
▨	sand & clay	⋮	well screen
▼	water table	❘	sample interval

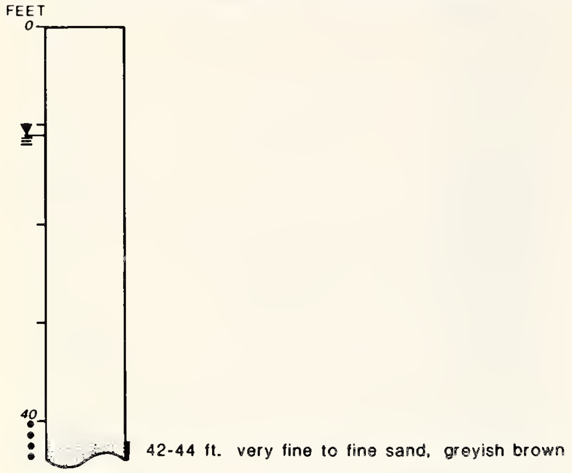
APPENDIX 4. TEST WELL LOGS, PINE BUSH AQUIFER (2 of 5)

(See appendix 1 for locations)

NEW YORK STATE GEOLOGICAL SURVEY
Geology, U.S.G.S. Graphics, J. Skiba 11/80

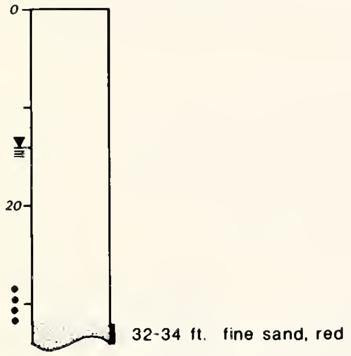
SITE 4 WELL 4C
Hole depth 44 ft. Well depth 44 ft.

300 FT. NE. OF THRUWAY UNDERPASS ALONG RT. 155 EAST
850 FT. SE. OF RT. 155 ALONG DIRT ROAD ON N. SIDE OF ROAD
150 FT. NW. OF WELL 4A, 4 FT. NE. OF WELL 4B



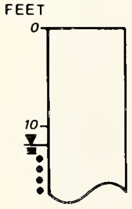
SITE 4 WELL 4E
Hole depth 34 ft. Well depth 32 ft.

300 FT. NE. OF THRUWAY UNDERPASS ALONG RT. 155 EAST
950 FT. SE. OF RT. 155 ALONG DIRT ROAD ON S. SIDE OF ROAD
50 FT. NW. OF WELL 4A
100 FT. SE. OF WELL 4B & WELL 4C, 5 FT. SE. OF WELL 4D



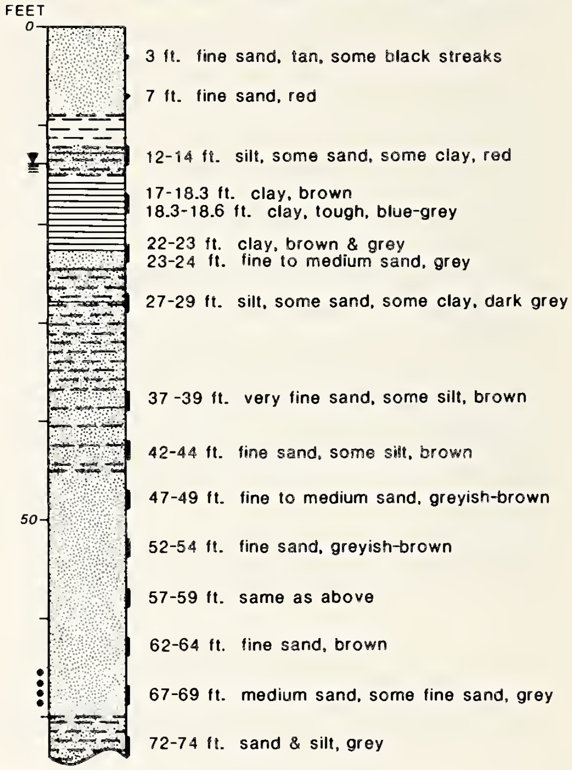
SITE 4 WELL 4F
Hole depth 17 ft. Well depth 17 ft.

300 FT. NE. OF THRUWAY UNDERPASS ALONG RT. 155 EAST
1000 FT. SE. OF RT. 155 ALONG N. SIDE OF DIRT ROAD
5 FT. SW. OF WELL 4A (WELL 4F IS CLOSER TO ROAD)



SITE 4 WELL 4D
Hole depth 74 ft. Well depth 69 ft.

300 FT. NE. OF THRUWAY UNDERPASS ALONG RT. 155 EAST
950 FT. SE. OF RT. 155 ALONG DIRT ROAD ON S. SIDE OF ROAD
50 FT. NW. OF WELL 4A 100 FT. SE. OF WELL 4B & 4C


FEET
0
50
3 ft. fine sand, tan, some black streaks
7 ft. fine sand, red
12-14 ft. silt, some sand, some clay, red
17-18.3 ft. clay, brown
18.3-18.6 ft. clay, tough, blue-grey
22-23 ft. clay, brown & grey
23-24 ft. fine to medium sand, grey
27-29 ft. silt, some sand, some clay, dark grey
37 -39 ft. very fine sand, some silt, brown
42-44 ft. fine sand, some silt, brown
47-49 ft. fine to medium sand, greyish-brown
52-54 ft. fine sand, greyish-brown
57-59 ft. same as above
62-64 ft. fine sand, brown
67-69 ft. medium sand, some fine sand, grey
72-74 ft. sand & silt, grey

EXPLANATION

░	sand	┅	silt
▨	sand & silt	☰	clay
⊻	water table	⋮	well screen
ǀ	sample interval		

APPENDIX 4. TEST WELL LOGS, PINE BUSH AQUIFER (3 of 5)

(See appendix 1 for locations)

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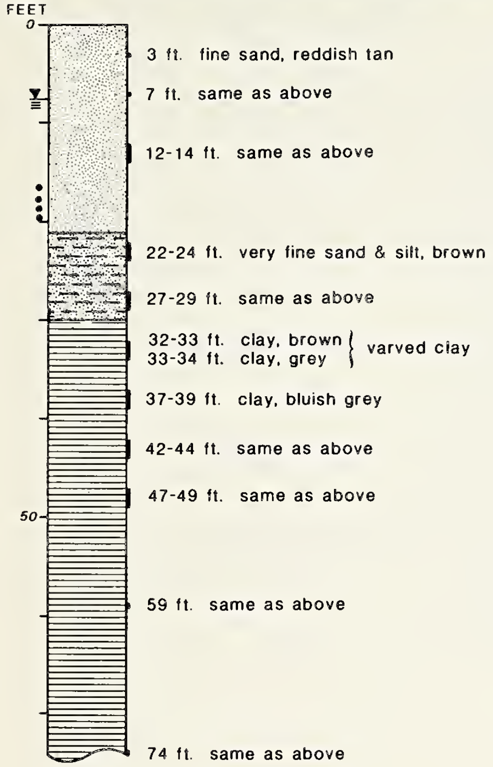
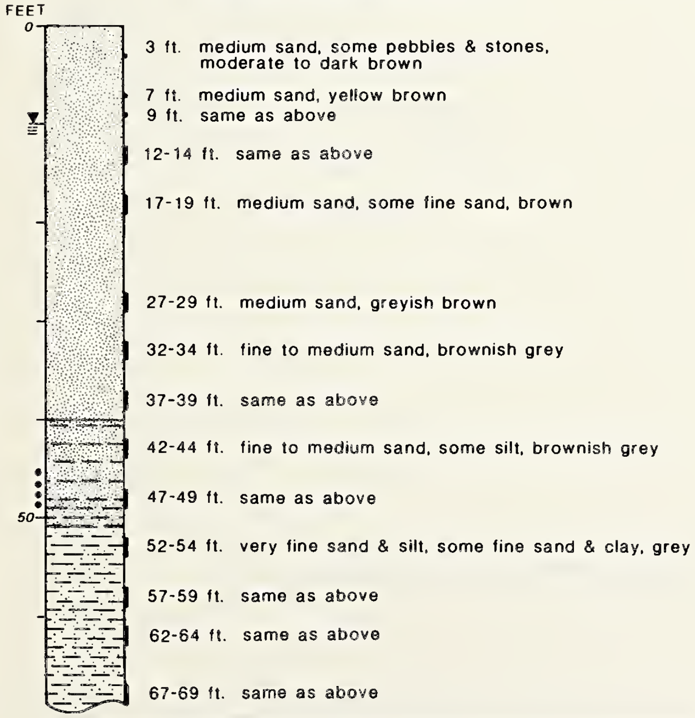
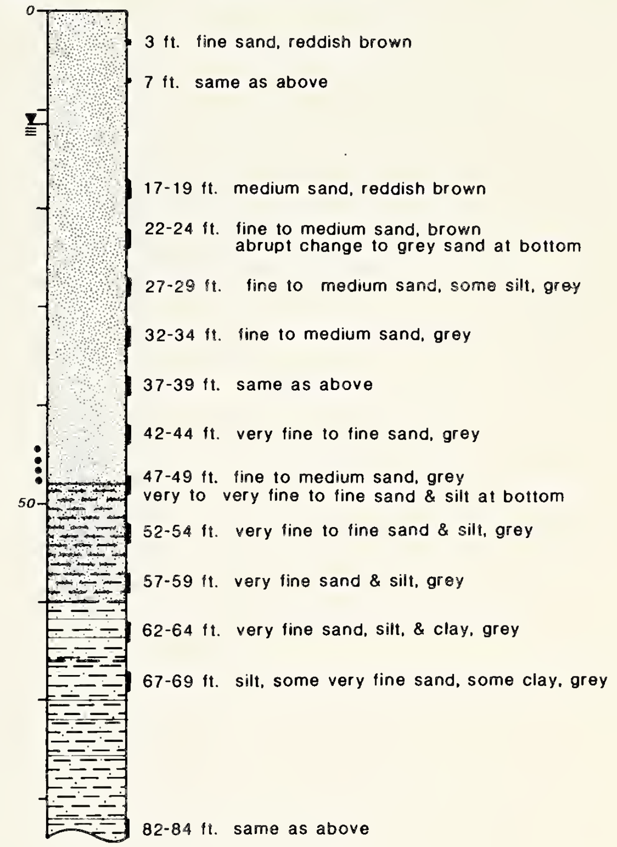
SITE 5 WELL 5A
Hole depth 74 ft. Well depth 20 ft.
2500 FT. NW. OF FULLER ROAD ALONG BLACKTOP ROAD
30 FT. NW. OF NORTHWAY OVERPASS S. OF RENSSELAER LAKE



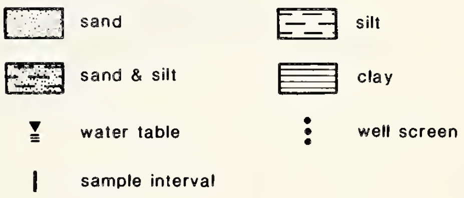
SITE 6 WELL 6A
Hole depth 69 ft. Well depth 49 ft.
560 FT. NW. OF THE ITALIAN-AMERICAN COMMUNITY CENTER
ALONG WASHINGTON AVE. EXT.
15 FT. NE. OF THE FRONTAGE ROAD


FEET
0
50
3 ft. medium sand, some pebbles & stones, moderate to dark brown
7 ft. medium sand, yellow brown
9 ft. same as above
12-14 ft. same as above
17-19 ft. medium sand, some fine sand, brown
27-29 ft. medium sand, greyish brown
32-34 ft. fine to medium sand, brownish grey
37-39 ft. same as above
42-44 ft. fine to medium sand, some silt, brownish grey
47-49 ft. same as above
52-54 ft. very fine sand & silt, some fine sand & clay, grey
57-59 ft. same as above
62-64 ft. same as above
67-69 ft. same as above

SITE 6 WELL 6B
Hole depth 84 ft. Well depth 48 ft .
500 FT. NW. OF THE ITALIAN AMERICAN COMMUNITY CENTER
ALONG WASHINGTON AVE. EXT. 15 FT. NE. OF THE FRONTAGE ROAD,
60 FT. SE. OF WELL 6A


FEET
0
50
3 ft. fine sand, reddish brown
7 ft. same as above
17-19 ft. medium sand, reddish brown
22-24 ft. fine to medium sand, brown abrupt change to grey sand at bottom
27-29 ft. fine to medium sand, some silt, grey
32-34 ft. fine to medium sand, grey
37-39 ft. same as above
42-44 ft. very fine to fine sand, grey
47-49 ft. fine to medium sand, grey very to very fine to fine sand & silt at bottom
52-54 ft. very fine to fine sand & silt, grey
57-59 ft. very fine sand & silt, grey
62-64 ft. very fine sand, silt, & clay, grey
67-69 ft. silt, some very fine sand, some clay, grey
82-84 ft. same as above

EXPLANATION



APPENDIX 4. TEST WELL LOGS, PINE BUSH AQUIFER (4 of 5)

(See appendix 1 for locations)

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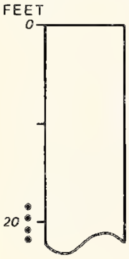
Geology, U.S.G.S. Graphics J. Skiba 11/80

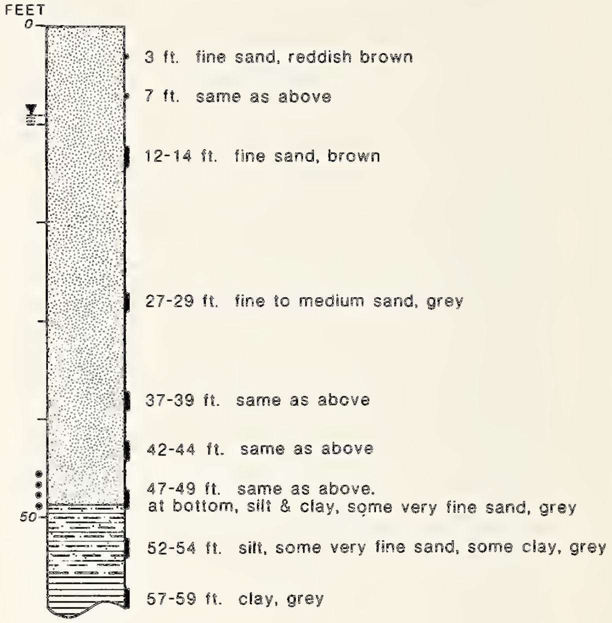
SITE 6 WELL 6C
Hole depth 22 ft. . Well depth 22 ft.

240 FT. NW. OF THE ITALIAN AMERICAN COMMUNITY CENTER
ALONG WASHINGTON AVE. EXT.
19 FT. NE. OF THE FRONTAGE ROAD
4 FT. NE. OF WELL 6B 60 FT. SE. OF WELL 6A



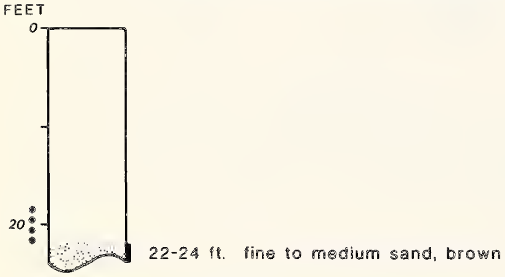
SITE 6 WELL 6D
Hole depth 59 ft. Well depth 49 ft.

600 FT. NW. OF THE ITALIAN AMERICAN COMMUNITY CENTER
ALONG WASHINGTON AVE. EXT.
15 FT. NE. OF THE FRONTAGE ROAD
40 FT. NW. OF THE WELL 6A


FEET
0
50
3 ft. fine sand, reddish brown
7 ft. same as above
12-14 ft. fine sand, brown
27-29 ft. fine to medium sand, grey
37-39 ft. same as above
42-44 ft. same as above
47-49 ft. same as above.
at bottom, silt & clay, some very fine sand, grey
52-54 ft. silt, some very fine sand, some clay, grey
57-59 ft. clay, grey

SITE 6 WELL 6E
Hole depth 24 ft. Well depth 22 ft.

80 FT. NW. OF THE ITALIAN AMERICAN COMMUNITY CENTER
ALONG WASHINGTON AVE. EXT.
11 FT. NE. OF THE FRONTAGE ROAD
40 FT. NW. OF WELL 6A, 4 FT. SW. OF WELL 6D



EXPLANATION

▨	sand	☰	silt
▨	sand & silt	☰	clay
▼	water table	⋮	well screen
❙	sample interval		

APPENDIX 4. TEST WELL LOGS, PINE BUSH AQUIFER (5 of 5)

(See appendix 1 for locations)

NEW YORK STATE GEOLOGICAL SURVEY Geology, U.S.G.S. Graphics, J. Skiba 11/80

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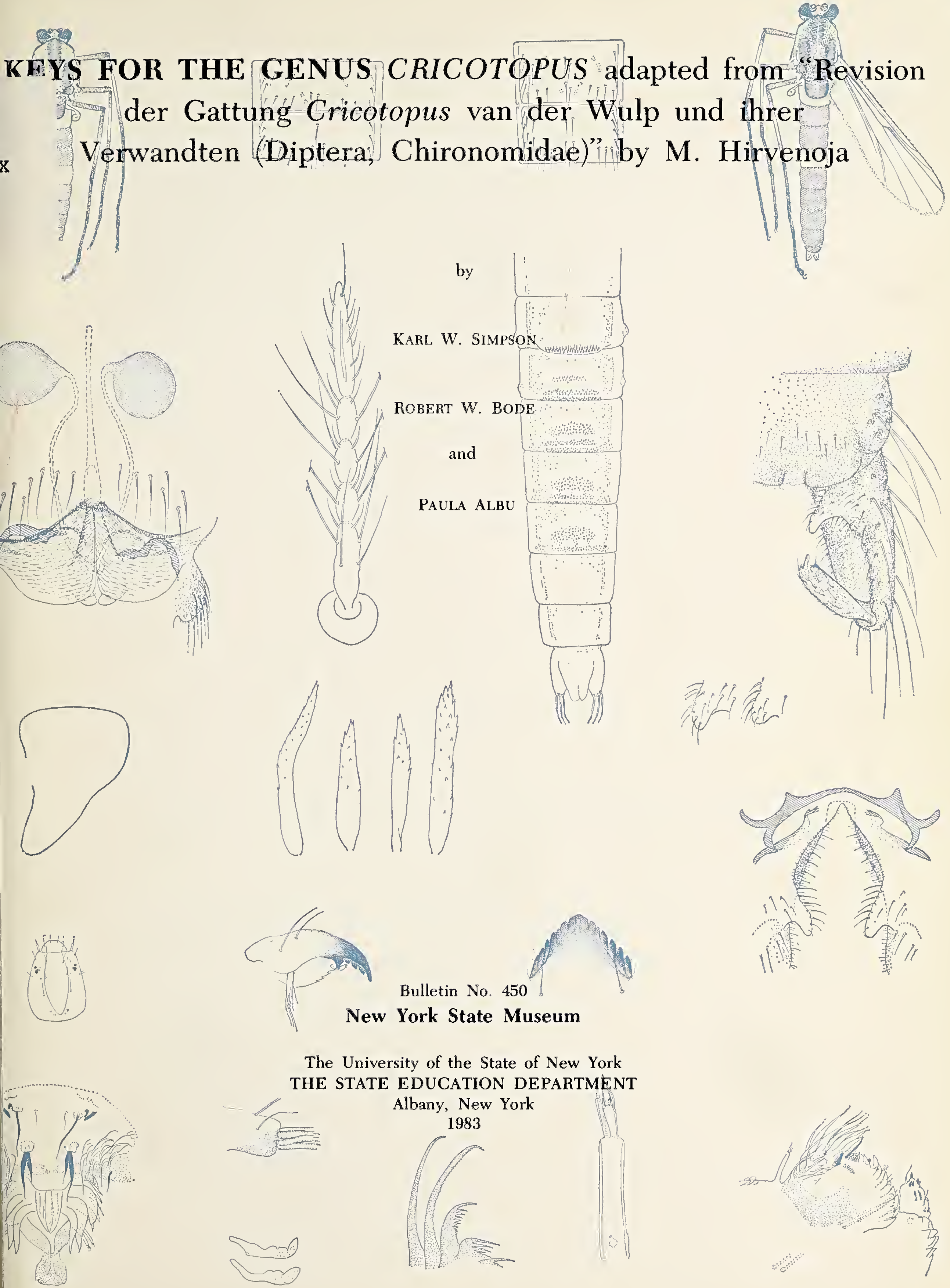

KEYS FOR THE GENUS *CRICOTOPUS* adapted from "Revision der Gattung *Cricotopus* van der Wulp und ihrer Verwandten (Diptera, Chironomidae)" by M. Hirvenoja

by

KARL W. SIMPSON

ROBERT W. BODE

and

PAULA ALBU

Bulletin No. 450

New York State Museum

The University of the State of New York
THE STATE EDUCATION DEPARTMENT
Albany, New York
1983

KEYS FOR THE GENUS *CRICOTOPUS* adapted from "Revision der Gattung *Cricotopus* van der Wulp und ihrer Verwandten (Diptera, Chironomidae)" by M. Hirvenoja

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and
Robert W. Bode

Center for Laboratories and Research
New York State Department of Health

and

Paula Albu

Eastern New Mexico University

in cooperation with

New York State Department of Environmental Conservation

and

New England Interstate Water Pollution Control Commission

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ABSTRACT

This publication presents the essence of Hirvenoja's (1973) keys and illustrations for adult males, adult females, pupae, and larvae for the genus *Cricotopus* in a format that is usable by itself. The applicability of the keys, which are based on European material, to the Nearctic fauna is discussed.

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INTRODUCTION

Members of the genus *Cricotopus* are a common and often abundant component of freshwater invertebrate communities. They occur in many habitats and under a wide range of water quality conditions. At present over 30 species have been described from the Nearctic region, but many additional species undoubtedly exist and await description. Taxonomic understanding of the North American fauna is poor, especially for the immature stages. LeSage and Harrison (1980b) described the adults, pupae, and larvae (where possible) of 11 species from a small Canadian stream and noted that a thorough revision of the Nearctic fauna is needed.

Hirvenoja (1973) revised the European species of *Cricotopus* and related genera and provided a wealth of information—including keys, descriptions, and illustrations, as well as taxonomic, morphological, and biological discussions—for some 70 species. This work will provide the foundation for revisions of the genus in other geographic regions and is a useful part of the literature base with which species determinations of field-collected specimens can be attempted. However, many applied biologists are unable to make full use of the keys and illustrations because the text is in German and because some of the couplets in the keys are rather lengthy and complex.

The purpose of this bulletin is to present Hirvenoja's superb illustrations and the essence of his keys in a form that is usable by itself. To this end we have not only translated the keys but have reorganized and simplified them as well. All information presented herein is taken from Hirvenoja and is restricted to the genus *Cricotopus*. The original work also included four smaller genera: *Acricotopus* (1 species), *Halocladius* (6 species), *Paracladius* (3 species), and *Paratrichocladius* (2 species).

After completing the literal translation, we organized the keys into four units: adult males, adult females, pupae, and larvae. We then simplified some of the couplets, sacrificing an understanding of phylogenetic relationships for usability. In particular the large, complex subgeneric couplets for adult males and pupae were eliminated. Instead, the various species groups of the subgenus *Cricotopus* were split off more or less individually in the early portions of these keys, after which the subgenus *Isocladius* was identified. The only change made in Hirvenoja's classification scheme (Table 1) was to recognize the subgenus *Nostococladius*, erected by Ashe and Murray (1980). The one affected species *(C. lygropis)* formerly was in the *lygropis*-group of the subgenus *Cricotopus*.

Although the subgenera are no longer separated in a single couplet, an attempt has been made to maintain the integrity of species-groups in the keys. This will help readers to understand the limits of species groups as established by Hirvenoja.

It was not possible to include Hirvenoja's lengthy morphological discussion, which explains the terminology used in his keys. Consequently the terminology was altered to conform with Saether (1980). The terms and abbreviations are listed in Table 2, and some figures have been labeled to help clarify the terminology.

Finally, figure numbers were added in the keys to help readers utilize the numerous and excellent illustrations. For each species the figure numbers are given after the species name in the keys and are listed in Table 1. Hirvenoja's original figure numbers have been retained and can be used as a type of index to his work. Hirvenoja interspersed the figures with the text, so that the descriptions, diagnoses, and biological information for a species are often located on the same or adjacent pages to the figures.

Adult, pupal, and larval diagnoses for *Cricotopus* are given by LeSage and Harrison (1980b). Generic keys for adult males are available in Brundin (1956, in German), Pinder (1978), and Oliver (1981). Saether (1977) provides a generic key for adult females. Larvae (L) and pupae (P) can be keyed, with varying success, in Beck (1976, L), Bryce and Hobart (1972, L), Chernovskii (1949, L), Cranston (1982, L), Hilsenhoff (1975, L), Mason (1973, L), Oliver et al. (1978, L), Pankratova (1977, L, P), Roback (1957, L, P), Simpson and Bode (1980, L), and Thienemann (1944, L, P; in German as *Eucricotopus* and *Trichocladius*). Keys for larvae, pupae, and adults of the Holarctic genera of Chironomidae are in preparation (Fittkau et al.) and will greatly facilitate the identification of chironomid specimens, including *Cricotopus*.

COMMENTS ON THE APPLICABILITY OF THE KEYS TO THE NEARCTIC FAUNA

The following keys contain different number of species because not all stages have been associated for all species. The key for adult males is complete, containing all 58 species listed in Table 1. Fewer species are included in the keys for adult females (54 species), pupae (40 species), and larvae (26 species).

Cricotopus is a large and taxonomically difficult genus. Among the problems encountered in attempting a specific identification is the extensive intraspecific variation, which can lead to overlapping diagnostic traits for closely related species. In adults this applies not only to numerical characters (such as the number of sensillae chaeticae and the values of AR, BR, BV, and LR) but also to qualitative characters (such as abdominal pigmentation, the arrangement of setae on abdominal tergites, and the shape of the male hypopygium). In adult males of *C. sylvestris*, for example, Hirvenoja (1973) found that the abdominal tergites may be uniformly pigmented or portions of tergites I, IV and V may have pale areas. Considerable variation can also occur in the immature stages. As an example, the frontal setae in the pupae of *C. triannulatus* and *C. curtus* usually are on the prefrons, but in some specimens they are on the frontal apotome. Even greater intraspecific variations are likely to be found as Nearctic material of Holarctic species is examined. Already LeSage and Harrison (1980b) have found that their adult specimens of *C. annulator* have a shorter wing length, a lower AR in males, and fewer sensillae chaeticae in the females than the European specimens.

Naturally, not all North American material will be identifiable to species and some will not correspond with any species group concepts. LeSage and Harrison (1980b) suggest that *C. politus* (Coq.) and *C. luciae* LeSage and Harrison should each be placed in its own species group.

The considerable number of Holarctic species renders Hirvenoja's work extremely valuable in helping to improve the taxonomic understanding of North American material. To date 24 of the 58 species have been reported as occurring in North America (Table 1); most of these probably occur in the northeastern United States. We have encountered 11 species representing six groups during our biomonitoring activities in New York State. The following comments on these species and groups supplement the taxonomic and distributional notes in Simpson and Bode (1980).

Cricotopus (Cricotopus) tremulus group

This group is comprised of many lotic species and is found in habitats ranging in size from small streams to large rivers. Various representatives occurred at 203 of our 225 sampling sites, but we have limited distributional data for individual species because the larvae are difficult to distinguish from one another. To date we have reared three species, *C. tristis*, *C. pulchripes*, and *C. triannulatus*, as well as some other species that do not fit any of Hirvenoja's descriptions. *Cricotopus exilis* Joh. is a junior synonym of *C. triannulatus* (LeSage and Harrison, 1980b). Six of Hirvenoja's nine species have already been recorded in North America (Table 1), and many additional species may exist. *C. infuscatus* and perhaps many other species in the *infuscatus*-group of Sublette and Sublette (1971) belong to the *tremulus*-group.

The larvae of some species closely resemble *Orthocladius* larvae and cannot be determined to genus without associated pupal or adult material. Generally speaking, larvae with setal tufts on the abdomen are *Cricotopus*, while larvae lacking these tufts could be either *Cricotopus* or *Orthocladius*.

The posterior portion of the pupal abdomen should be mounted carefully, since the location and size of the setae on segment VIII are important for group- and species-level identifications.

Cricotopus (Cricotopus) festivellus group

We have reared a species from the St. Lawrence River that fits the group characters as an adult but not in the pupal or larval stages. LeSage and Harrison (1980a) list *C. festivellus* as occurring in two Canadian streams.

Cricotopus (Cricotopus) bicinctus group

Both *C. bicinctus* and *C. vierriensis* occur in New York, and all stages can be determined fairly easily with Hirvenoja's keys. *C. bicinctus* is probably the most common species of *Cricotopus* in North America (LeSage and Harrison 1980a,b), and the larvae are found under a wide range of habitat types and water quality conditions. In New York State we have found it at 220 of 225 sampling sites; it is present in diverse, well-balanced macroinvertebrate communities and increases in abundance when stresses (such as heavy metals) eliminate more sensitive species. According to Hirvenoja (1973, p. 238) the larvae live primarily in flowing waters; but they are also often abundant in brackish waters, along with *C. sylvestris*, *C. triannulatus*, and some other common *Cricotopus* species. Due to its wide geographic distribution and the morphological variation in the adults, Oliver (1977) raised the possibility that *C. bicinctus* is actually a species complex.

Cricotopus vierriensis is much less common than *C. bicinctus*. We have found it in two small productive streams, and LeSage and Harrison (1980a) found it in one of the four streams they sampled. According to Hirvenoja (1973, p. 242) the larvae inhabit both standing and flowing waters and can tolerate waters with high salt concentrations.

Cricotopus (Cricotopus) trifascia group

The *trifascia*-group is very distinctive in all stages and can be determined easily by using Hirvenoja's keys. The larvae are rheophilous and occur in both clean and polluted waters. For example, LeSage and Harrison (1980a) reported *C. trifascia* to be the dominant species in a river with severe industrial, urban, and agricultural pollution. *Cricotopus ithacaensis* (Sublette, 1967) is a junior synonym of *C. trifascia* (LeSage and Harrison, 1980b). Of the two species assigned to this group, the immature stages of only one *(C. trifascia)* are known.

Cricotopus (Isocladius) sylvestris group

This large group contains 12 of the 22 species in the subgenus *Isocladius*. The larvae of this group are easily recognizable, being the only members of the subgenus with bifid premandibles. To date six species have been reported from North America, and we have reared three of these (Table 1). The most commonly occurring species is *C. sylvestris*, which we have reared from a wide range of habitats, including slowly moving, turbid canals, a large brackish estuary (Hudson River), and a large, swift-flowing river (St. Lawrence). According to Hirvenoja (1973, p. 283) the larvae inhabit standing and slowly flowing water and occur in brackish water to about 8 percent salinity. The species occurs principally in habitats rich in vegetation and plant remains, but it can also inhabit waters with very low concentrations of dissolved oxygen.

Cricotopus trifasciatus (small form) is much less common than *C. sylvestris*, and these two species often occur in the same samples. Hirvenoja (1973, p. 290) reviewed the literature and concluded that the larvae of *C. trifasciatus* (small form) feed on the leaves of several kinds of aquatic plants, including *Limnanthemum nymphoides*, *Polygonum amphibium*, *Potamogeton natans*, *Nuphar luteum*, and *Nymphaea* sp.

We have found *C. tricinctus* thus far at only one site in a small, productive stream. Hirvenoja (1973, p. 304) lists the larvae of this species as occurring in ponds, lakes, and slowly moving waters, where it mines the leaves of *Potamogeton natans* and certain other aquatic plants.

Cricotopus (Isocladius) intersectus group

All stages of the *intersectus*-group key out fairly well, but the pupa is most easily recognized due to the strong granulations on the dorsal portion of the thorax (Fig. 199_1). There is only one European species in this group *(C. intersectus)*, and our material is considerably different, representing one (or more) different species. In New York State it occurs in large rivers and canals, including some areas subjected to severe organic and toxic waste loadings. In Europe *C. intersectus* is characteristic of eutrophic lakes, and the larvae can exist under an extremely wide range of dissolved oxygen concentrations.

Table 1. Classification scheme for European *Cricotopus* (after Hirvenoja, 1973)

	Nearctic records*			Stages known				Figures
				A♂	A♀	P	L	
Cricotopus								
(Cricotopus)								
pilosellus-group								
villosus	a			X				72
pilosellus				X	X	X		73–75
pilidorsum				X	X	X		75
tibialis-group								
cumulatus				X	X			76–78
gelidus				X	X			83
lestralis				X	X			84
ephippium				X	X	X		79–82
tibialis	a		c	X	X	X	X	85–90
polaris	a			X	X	X		90–94
fuscus-group								
fuscus				X	X	X	X	95–101
algarum				X	X	X	X	96–97, 100–103
pirifer				X	X	X	X	95–97, 100–101, 104–105
magus-group								
magus				X	X	X		105–106
tremulus-group								
septentrionalis				X	X			107–108
pulchripes		b		X	X			109–110
tremulus	a			X	X	X	X	111–115
claripes				X	X			116
tristis	a	b		X	X	X		117
curtus		b		X	X	X	X	118–121
annulator	a		c	X	X	X	X	122–123
beckeri				X	X			124–125
triannulatus	a		c	X	X	X	X	126–127
cylindraceus-group								
cylindraceus	a			X	X	X	X	129–131
patens				X	X	X	X	130, 132–134
coronatus	a			X	X	X		130, 135
festivellus-group		b						
festivellus	a		c	X	X	X		130, 136–137
flavocinctus				X	X	X	X	138–139
albiforceps				X	X	X	X	140–141
bicinctus-group								
bicinctus	a	b	c	X	X	X	X	142–143
vierriensis	a	b	c	X	X	X	X	144–145
pallidipes				X	X			146
trifascia-group								
trifascia		b	c	X	X	X	X	147–150
similis				X	X			151
caducus-group								
guttatus				X				153
caducus				X	X	X		152, 154

(Nostococladius)								
lygropis				X	X			128
(Isocladius)								
dobrogicus-group								
dobrogicus				X	X			155–156
sylvestris-group								
ornatus	a			X	X	X	X	157–159
laetus				X	X	X	X	160–164
pilitarsis	a			X	X	X		165–167
pilicauda				X				168
relucens				X	X	X		169–170
sylvestris	a	b	c	X	X	X	X	171–176
glacialis	a			X	X			177
suspiciosus				X	X	X	X	178–180
trifasciatus, large form				X	X			181–182
trifasciatus, small form		b		X	X	X	X	183–186
speciosus				X	X			187–188
tricinctus	a	b		X	X	X	X	185, 189–191
reversus-group								
reversus				X	X	X	X	192–194
perniger				X	X	X		195
intersectus-group								
intersectus	a	b		X	X	X	X	196–200
laricomalis-group								
arcuatus				X	X	X		201–203
obtusus				X	X	X		204
laricomalis	a			X	X	X	X	205–207
obnixus-group								
reductus				X				212
obnixus	a			X	X	X	**	203, 208–211
brevipalpis-group								
brevipalpis				X	X	X	X	213–215

* a — listed as Holarctic by Hirvenoja
b — collected during New York State biomonitoring activities
c — reported by LeSage and Harrison (1980a, 1980b)

** *C. elegans* (?=*obnixus*)

Table 2. Terms and abbreviations used in keys (after Saether, 1980). Figure numbers indicate where corresponding structures are labeled.

ADULTS

Morphological terms

AnP	Anal point (Fig. 108, 116)
APa	Anterior prealar setae (Fig. 73)
APs	Antepronotal setae (see "MAps" below)
BS	Basal setae (Fig. 129, 135, 193, 205)
CD	Crista dorsalis (Fig. 86, 92, 137)
Dc	Dorsocentral setae (Fig. 76)
Gc	Gonocoxite (Fig. 86 (♂), 128 (♀))
Gs	Gonostylus (Fig. 86, 170)
H	Humeral setae (Fig. 155, 165)
IVo	Inferior volsella (Fig. 77, 86)
LS	Lateral setae (Fig. 96, 148, 151)
MAps	Median setae of antepronotum (Fig. 91, 155)
MaS	Marginal setae (Fig. 135, 193, 205)
MD_1	Anteromedian muscle marks (Fig. 83, 96)
MD_2	Posteromedian muscle marks (Fig. 96, 138)
MS	Median setae (Fig. 96, 138)
P_{1-3}	Legs (fore, middle and hind, respectively)
Pes	Preepisternal setae (Fig. 73, 192)
PPa	Posterior prealar setae (Fig. 73, 76)
Pts	Paratergital setae (Fig. 76, 83, 96)
SCa	Seminal capsule (Fig. 154)
SCh	Sensillae chaeticae (Fig. 5)
Scts	Scutellar setae (Fig. 76, 196, 201)
SDu	Spermathecal duct (Fig. 140, 154)
SVo	Superior volsella (Fig. 86, 117, 177, 187, 202, 204, 208, 213)

Ratios

AR	Antennal ratio: ratio of length of apical elongated flagellomere plus any flagellomeres distal to it divided by combined length of the more basal flagellomeres.
BR	"Bristle ratio": ratio of longest seta of basal tarsomere divided by minimum width of the tarsomere measured one third from apex. (BR without subscript refers to front leg, BR_{1-3} are ratios of front, mid and hind legs.)
BV	"Beinverhältnisse": combined length of femur, tibia and basitarsus (=basal tarsomere) divided by combined length of tarsomeres 2–5. (BV without subscript refers to front legs; BV_{1-3} to front, mid and hind legs, respectively.)
LR	Leg ratio: ratio of basal tarsomere to tibia. (LR without subscript refers to front leg; LR_{1-3} refer to ratio of front, mid and hind legs, respectively.)

Table 2 (continued)

PUPAE

Morphological terms

AM	Anal macrosetae (Fig. 148)
D	D setae (Fig. 93, 97, 120, 157, 172, 174)
Dc	Dorsocentral setae (Fig. 87, 93)
FA	Frontal apotome (Fig. 79)
FS	Frontal setae (Fig. 79)
Hl	Hooklets (Fig. 169, 214)
L	L setae (Fig. 93, 97, 120, 157, 172, 174)
MD	Muscle marks (Fig. 137, 174, 195)
O	Oral setae (Fig. 174)
OF	Ocular field (Fig. 79)
Po	Postorbital setae (Fig. 79)
Prfr	Prefrons (Fig. 79)
PSB	Pedes spurii B (Fig. 117, 122, 142, 163, 199)
TH	Thoracic horn
V	V setae (Fig. 157, 172, 174)

LARVAE

Morphological terms

AP	Anterior parapod
ChB	Chaetulae basales (Fig. 191)
ChL	Chaetulae laterales (Fig. 191)
M	Mentum
PE	Pecten epipharyngis (Fig. 88, 176, 191)
Pm	Premandible (Fig. 88, 115)
PmB	Premandibular brush (Fig. 88, 115)
RO	Ring organ (Fig. 159)
Si	Seta interna (mandible) (Fig. 210)
SI	Seta anteriores (labrum) (Fig. 207, 210)

Ratio

AR	Antennal ratio: length of basal antennal segment divided by the combined length of the remaining segments. (This is the inverse of the antennal ratio used by Hirvenoja in the original work.)

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KEYS FOR *CRICOTOPUS*

Adult males (58 species)

1 Gonocoxite without inferior volsella (Fig. 147_3); abdominal tergites I and IV light (Subgenus *Cricotopus*, in part—*trifascia*-group) 2

Gonocoxite with inferior volsella (e.g. Fig. 77_3); pigmentation of abdominal tergites variable 3

2 Abdominal tergites III-IV each with 10–19 lateral setae (Fig. 148_1); AR 1.51–1.79; first tarsomere of P_3 with 27–39 sensillae chaeticae on its basal half .... *trifascia* Edw. (Fig. 147, 148)

Abdominal tergites III-IV each with 3–7 lateral setae (Fig. 151_6); AR 1.04–1.25; first tarsomere of P_3 with 8–10 sensillae chaeticae on its basal 1/4–1/3... *similis* Goetgh. (Fig. 151)

3 Anterior prealar setae present, somewhat smaller than and merged with posterior prealar setae (Fig. 73_1) (Subgenus *Cricotopus*, in part—*pilosellus*-group) 4

Anterior prealar setae absent (e.g. Fig. 76_1) 6

4 BR (ratio of longest seta of a tarsomere divided by minimum width of same tarsomere) of third tarsomere of p_1 greater than 3.5 .... *villosus* Hirv. (Fig. 72)

BR of this tarsomere less than 3.5 5

5 Preepisternal setae present (Fig. 73_1) .... *pilosellus* Brund. (Fig. 73, 74)

Preepisternal setae absent .... *pilidorsum* Hirv.

6 Setae on abdominal tergites and scutellum usually uniformly distributed and usually dense (Fig. $76_{1,5}$); numerous paratergital setae on most or all segments (Fig. 83_4); inferior volsella either bilobed or not distinctly longer than wide (Fig. 77_3, 80_3, 83_3) (Subgenus *Cricotopus*, in part—*tibialis*-group) 7

Setae on abdominal tergites (at least III and IV) usually reduced to groups or rows, not uniformly distributed; paratergital setae less numerous (e.g. Fig. 126_5) or absent; if setae on tergites III and IV uniformly distributed, inferior volsella simple and rounded apically (Fig. 156_7, 193_9) 12

7 Inferior volsella simple and about as long as wide (Fig. 77_3); BR of third tarsomere of p_1 about 4.6 (4.0–5.8) .... *cumulatus* Hirv. (Fig. 76, 77)

Inferior volsella wider than long or more or less bilobed; BR usually much less 8

8 Inferior volsella wider than long, at most slightly bilobed 9

Inferior volsella distinctly bilobed 11

9 AR less than 1 .... *ephippium* (Zett.) (Fig. 79, 80)

AR greater that 1 10

10 Setae not uniformly distributed over abdominal tergites, with bare areas evident in region of anteromedian muscle marks (MD_1) (Fig. 83_1) .... *gelidus* (Kieff.) (Fig. 83)

Setae uniformly distributed over abdominal tergites .... *lestralis* (Edw.) (Fig. 84)

11 Crista dorsalis pointed distally, otherwise relatively narrow (Fig. 92_3); apical tooth and distal setae of gonostylus remarkably long .... *polaris* Kieff. (Fig. 91, 92, 94)

Crista dorsalis wide and often rounded apically, never distinctly pointed; apical tooth and distal setae of gonostylus of normal size (Fig. 86_3) .... *tibialis* (Meig.) (Fig. 85–87, 89)

12 AR distinctly less than 1.0; tarsi of p_2 and p_3 strongly shortened (BV_2 greater than 4.5, BV_3 greater than 4.0); inferior volsella simple, rounded and somewhat teardrop-shaped (Fig. 153_2, 154_6) (Subgenus *Cricotopus*, in part—*caducus*-group) 13

AR normally greater than 1.0; when less than 1.0, tarsi not shortened (BV_2 less than 4.5, BV_3 less than 4.0) 14

13 Tibiae of p_2 and p_3 with two spurs; LR_1 0.56–0.62; LR_2 0.24–0.25; inferior volsella wider than in following species .... *guttatus* Hirv. (Fig. 153)

Only one tibial spur on all legs (Fig. 152_1); LR_1 0.47–0.55; LR_2 0.32–0.38 .... *caducus* Hirv. (Fig. 152, 154)

14 Abdominal tergites III-IV each with a transverse row of basal setae (Fig. 129_4); longitudinal rows of median setae absent or indistinct; inferior volsella often bilobed (Fig. 129_3), if only weakly (Fig. 135_{11}), sensillae chaeticae present on first tarsomere of p_2 (Subgenus *Cricotopus*, in part) 15

Abdominal tergites III-IV each usually without a transverse row of basal setae (e.g. Fig. 137_1); if these present, inferior volsella simple and rounded apically and sensillae chaeticae absent on first tarsomere of p_2 18

15 Inferior volsella distinctly bilobed (Fig. 106_6); legs and abdominal tergites unicolorous; p_2 without sensillae chaeticae (*magus*-group) .... *magus* Hirv. (Fig. 106)

Inferior volsella simple, conical and strongly curved posteriorly or weakly bilobed; if weakly bilobed, legs and/or tergites with pale markings, first tarsomeres of p_2 and p_3 with sensillae chaeticae (*cylindraceus*-group) 16

16 Tibiae without rings; first tarsomere of p_2 with 2–6 sensillae chaeticae on its basal fourth; that of p_3 with 2–5 sensillae chaeticae on its basal fifth .... *coronatus* Hirv. (Fig. 135)

Tibiae with pale rings; tergite I sometimes pale 17

17 Abdominal tergites with relatively distinct pale bands (Fig. 129_1); first tarsomere of p_2 with 4–10 sensillae chaeticae, that of p_3 with 9–15 sensillae chaeticae on its basal third .... *cylindraceus* (Kieff.) (Fig. 129)

Abdominal tergites unicolorous (Fig. 133_3); first tarsomere of p_2 with 1–5 sensillae chaeticae on its basal fifth, that of p_3 with 2–7 sensillae chaeticae .... *patens* Hirv. (Fig. 130, 132, 133)

18 Median setae on tergites III-IV usually in a single longitudinal row (Fig. 138_1), rarely indistinctly double; inferior volsella weakly bilobed or simple (Fig. 137_7), often conical and strongly curved posteriorly; crista dorsalis distinct; fore tarsi dark, fore tibiae ringed; abdominal tergites with light markings; first tarsomeres of p_2 and p_3 with sensillae chaeticae (Subgenus *Cricotopus*, in part—*festivellus*-group) 19

Median setae on tergites III-IV usually either undifferentiated or in double longitudinal rows (e.g. Fig. 96_1); if these in a single row, inferior volsella simple and not strongly curved posteriorly and sensillae chaeticae absent on first tarsomere of p_2 (some *Isocladius*) *or* tergites I and IV pale (*Cricotopus* (*C.*) *vierriensis*—Fig. 144) 21

19 Abdominal tergites I, II and IV pale .... *albiforceps* (Kieff.) (Fig. 140)

Pigmentation of abdominal tergites otherwise 20

20 Posterior fourth of tergite IV and anterior fourth of tergite V pale (Fig. 137_3); hypopygium as in Fig. 137_7 .... *festivellus* (Kieff.) (Fig. 136, 137)

Tergites IV and V uniformly pigmented, tergite I pale; hypopygium as in Fig. 138_6 .... *flavocinctus* (Kieff.) (Fig. 138)

21 Lateral setae arranged in one or two rows on posterolateral margins of tergites III-IV (Fig. 117_5) **and** superior volsella rounded (Fig. 117_9) or absent; legs and tergites often with light areas (Subgenus *Cricotopus*, in part) 22

Lateral setae usually arranged in several rows on posterolateral margins of tergites III-IV (Fig. 128_6, 158_1); if these in one or two rows, superior volsella distinctly humped (e.g. Fig. 202_8, 204_7) 33

22 Abdominal tergites either unicolorous or tergites I and IV pale; inferior volsella always simple and more or less curved posteriorly; median setae on tergites III-IV single or double (*bicinctus*-group) 23

Tergites I and II usually pale; when pigmentation otherwise, inferior volsella distincly bilobed (e.g. Fig. 126_{10}); inferior volsella usually bilobed, if simple either directed medially (Fig. 116_3), curved posteriorly (Fig. 112_5) or broadened apically (Fig. 108_6, 109_4); median setae on tergites III-IV always distinctly double (*tremulus*-group) 25

23 Abdominal tergites unicolorous (Fig. 146_2); crista dorsalis distinct .... *pallidipes* Edw. (Fig. 146)

Abdominal tergites I and IV usually pale; crista dorsalis indistinct 24

24 Concavity of gonocoxite between base of gonostylus and inferior volsella much longer than wide; apex of inferior volsella does not reach middle of this concavity (Fig. 142_7)................ *bicinctus* (Meig.) (Fig. 142)

Concavity of gonocoxite rounded (Fig. 144_3); apex of inferior volsella reaches middle of this concavity .... *vierriensis* Goetgh. (Fig. 144)

25 Fore tarsi with pale rings 26

Fore tarsi uniformly dark; inferior volsella more or less distinctly bilobed; basal lobe narrow and directed medially, distal lobe directed somewhat posteriorly................ 29

26 Only second tarsomere pale; inferior volsella very wide and truncate apically (Fig. 109_4); anal point usually absent................ *pulchripes* Verr. (Fig. 109)

Second tarsomere of p_1 and at least basal half of third tarsomere pale................ 27

27 Inferior volsella wide and bluntly rounded (Fig. 108_6); anal point present................ *septentrionalis* Hirv. (Fig. 107, 108)

Inferior volsella narrower, its basal lobe foot-shaped or straight and directed medially.... 28

28 Basal lobe of inferior volsella foot-shaped (Fig. 112_5), distal lobe somewhat distinct; anal point absent .... *tremulus* (L.) (Fig. 111, 112)

Basal lobe straight, directed medially, distal lobe somewhat indistinct; anal point present (Fig. 116_3) .... *claripes* Hirv. (Fig. 116)

29 Crista dorsalis narrow, pointed apically; small anal point present (Fig. 117_8) .... *tristis* Hirv. (Fig. 117)

Crista dorsalis wider, not pointed apically; anal point absent 30

30 Abdominal tergites I and IV pale (Fig. 124_1) .... *beckeri* Hirv. (Fig. 124)

Abdominal pigmentation otherwise 31

31 Abdominal tergites unicolorous (completely dark) or tergites I, IV and V pale (Fig. 126_1) .... *triannulatus* (Macq.) (Fig. 126)

Abdominal pigmentation otherwise 32

32 Tergites I and II and posterior margins of next few tergites pale (Fig. 119_1); distal lobe of inferior volsella weak (Fig. 119_4) .... *curtus* Hirv. (Fig. 118, 119)

All tergites with at least some pigmentation (Fig. 122_1); distal lobe of inferior volsella relatively well developed (Fig. 122_8) .... *annulator* Goetgh. (Fig. 122)

33 Anal point present, inferior volsella simple and directed posteriorly (Fig. 128_3); legs and tergites uniformly pigmented (Fig. 128_1) (Subgenus *Nostococladius*)................ ?*lygropis* Edw. (Fig. 128)

Anal point absent, inferior volsella simple or bilobed; pigmentation variable 34

34 Inferior volsella bilobed (Subgenus *Cricotopus*, in part—*fuscus*-group)................ 35

Inferior volsella simple (Subgenus *Isocladius*)................ 37

35 Anterior margin of basal lobe of inferior volsella and posterior margin of distal lobe divergent (Fig. 104_3) .... *pirifer* Hirv. (Fig. 96, 100, 104)

Anterior margin of basal lobe of inferior volsella and posterior margin of distal lobe convergent or parallel (Fig. 98_3, 102_3)................ 36

36 LR_1 0.63–0.73 ($\bar{x}$ = 0.68)................ *fuscus* (Kieff.) (Fig. 95, 96, 98, 100)

LR_1 0.68–0.72 ($\bar{x}$ = 0.70)................ *algarum* (Kieff.) (Fig. 96, 100, 102)

37 Humeral setae and median antepronotal setae present (Fig. $155_{1,2}$) (*dobrogicus*-group) .... *dobrogicus* Albu (Fig. 155, 156)

These setae absent 38

38 Transverse rows of basal and marginal setae absent (e.g. Fig. 189_6); median setae on tergites II-IV in a single longitudinal row, more or less separated from lateral setae; light markings usually present on legs and abdomen; small but distinct pulvillae present (*sylvestris*-group) 39

Transverse rows of basal and/or marginal setae usually distinct on all abdominal tergites (Fig. 205_1); legs and abdominal tergites sometimes unicolorous; small pulvillae present or absent 50

Adult males (continued)

39 Inferior volsella about 40 μm wide, truncate or broadly rounded apically (not strongly tapered apically) (Fig. 166_4, 168_2) 40

Inferior volsella distinctly narrower (measured at about its middle) and distinctly tapered apically (e.g. Fig. 172_6) 41

40 First tarsomere of p_3 with 27–39 sensillae chaeticae; BR of third tarsomere of p_1 2.9–3.7 .... *pilitarsis* (Zett.) (Fig. 165, 166)

First tarsomere of p_3 with 5–6 sensillae chaeticae; BR of third tarsomere of p_1 1.3–2.3 .... *pilicauda* Hirv. (Fig. 168)

41 Scutellar setae 2–3 μm thick; median setae on abdominal tergites less than 4 μm thick .. 42

Scutellar setae and median setae of abdominal tergites 4–5 μm thick 43

42 Gonostylus at most 4 times as long as wide and bent slightly, when directed anteriorly it reaches no further than middle of inferior volsella (Fig. 157_5); BR of third tarsomere of p_1 3.9–5.9 .... *ornatus* (Meig.) (Fig. 157, 158)

Gonostylus more than 4 times as long as wide and fairly straight, when directed anteriorly it reaches completely over inferior volsella (Fig. 170_1); BR of third tarsomere of p_1 1.3–2.0 .... *relucens* Hirv. (Fig. 169, 170)

43 16–36 lateral setae on tergites II–IV; AR greater than 2.0; dark, relatively wide stripes on all but first abdominal tergite (Fig. 160_1) or pigmentation similar to light form of *C. sylvestris* (Fig. 172_2) .... *laetus* Hirv. (Fig. 160, 161)

Lateral setae less numerous and often smaller than median setae; if AR greater than 2, tergites I, IV and VII with large, pale areas 44

44 Abdominal tergites usually all dark (Fig. 172_1); when tergites I, IV and VII with pale areas, anterior ⅓ of tergite V also pale (Fig. 172_2) (the identification of the light forms of these species is often possible only with associated pupae or adult females) 45

Abdominal tergites I, VII (and sometimes IV) with large pale areas, other tergites dark .. 46

45 First tarsomere of p_3 with 15–30 sensillae chaeticae; abdominal tergites I–V entirely dark (Fig. 172_1) or tergites I, IV and V with pale areas (Fig. 172_2) .... *sylvestris* (Fabr.) (Fig. 171, 172)

First tarsomere of p_3 with 9 sensillae chaeticae; abdomen very dark (Fig. 177_1) .... *glacialis* Edw. (Fig. 177)

46 Abdominal tergite I and posterior ⅔ of tergite VII pale; thorax pale dorsally between vittae .... *suspiciosus* Hirv. (Fig. 178)

Abdominal tergites I, IV and VII with pale areas; thorax pale or dark dorsally 47

47 Tergite IV usually entirely pale, occasionally with some pigmentation in region of posteromedian muscle marks (Fig. 181_1); area between vittae pale 48

If tergite IV not entirely pale, pigmentation darkest in anterior corners of tergite (Fig. 187_1); prescutellar area or entire area between vittae usually dark 49

48 First tarsomere of p_3 with 42–45 sensillae chaeticae; AR 1.92–2.04 .... *trifasciatus* (Meig.) (large form) (Fig. 181, 182)

First tarsomere of p_3 with 9–17 sensillae chaeticae; AR 1.58–1.80 .... *trifasciatus* (Meig.) (small form) (Fig. 183)

49 First tarsomere of p_3 with 47–70 sensillae chaeticae; pigmentation of tergites and structure of hypopygium as in Fig. 187 .... *speciosus* Goetgh. (Fig. 187, 188)

First tarsomere of p_3 with 13–32 sensillae chaeticae; pigmentation of tergites and structure of hypopygium as in Fig. 189 .... *tricinctus* (Meig.) (Fig. 189)

50 Transverse rows of basal and marginal setae present (Fig. 193_1, 195_1) on abdominal tergites III–IV; superior volsella and pulvillae absent (*reversus*-group) 51

Transverse rows of basal setae absent on abdominal tergites III and IV; simple longitudinal row of median setae usually distinct, but merges with lateral setae through transverse row of marginal setae 52

51 Preepisternal setae present (Fig. 192_1) .... *reversus* Hirv. (Fig. 192, 193)

Preepisternal setae absent................................ *perniger* (Zett.) (Fig. 192, 195)

52 Superior volsella absent; scutellum usually with dense setae, dorsocentral setae numerous (Fig. 196); tergites I and IV occasionally somewhat lightened (Fig. 198_2); pulvillae absent (*intersectus*-group) .... *intersectus* (Staeg.) (Fig. 196–198)

Superior volsella more or less distinct; scutellar setae less numerous than in above species and usually in a single row (Fig. 201_3); dorsocentral setae less numerous; abdominal tergites all dark; small pulvillae sometimes present 53

53 Superior volsella produced into a definite hump (Fig. 177_4) (*laricomalis*-group) 54

Superior volsella rounded, flattened (e.g. Fig. 208_9) 56

54 Pulvillae absent; inner margin of gonocoxite between inferior volsella and gonostylus strongly curved (Fig. 202_{10}); first tarsomere of p_3 with 13–15 sensillae chaeticae................. .... *arcuatus* Hirv. (Fig. 201, 202)

Small pulvillae present; inner margin of gonocoxite less strongly rounded (Fig. 205_{10}); tibiae usually ringed; number of sensillae chaeticae lower...................................55

55 Hypopygium usually pale distally; crista dorsalis fairly wide, rounded distally (Fig. 204_8); first tarsomere of p_3 with 8–12 sensillae chaeticae .... *obtusus* Hirv. (Fig. 204)

Hypopygium dark; crista dorsalis dark, narrow, short and slightly bent (Fig. 205_{10}); first tarsomere of p_3 with 3–8 sensillae chaeticae .... *laricomalis* Edw. (Fig. 201, 205)

56 Palps short; their length less than ½ width of head (*brevipalpis*-group)................... .... *brevipalpis* Kieff. (Fig. 213, 214)

Palps long; their total length more than ½ width of head (*obnixus*-group) 57

57 Inferior volsella about 25 μm wide (Fig. 208_8).................. *obnixus* (Walk.) (Fig. 208)

Inferior volsella about 40μm wide (Fig. 212_3).......................................58

58 Anal lobe of wing moderately projected; AR over 1............ sp. cfr. *obnixus* (Fig. 211)

Anal lobe of wing reduced; AR 0.76–0.78 .... *reductus* Hirv. (Fig. 212)

Adult females (54 species)

1 Humeral setae and pulvillae absent 2

Humeral setae usually present (e.g. Fig. 165); when absent (one species) maxillary palps very short (less than ½ as long as maximum width of head) and small pulvillae present (Subgenus *Isocladius*) 35

2 Anterior prealar setae present, somewhat shorter than and merged with posterior prealar setae (Fig. 73_1) (Subgenus *Cricotopus*, in part-*pilosellus*-group) 3

Anterior prealar setae absent 4

3 Preepisternal setae present (Fig. 73_1) .... *pilosellus* Brund. (Fig. 73–75)

Preepisternal setae absent .... *pilidorsum* Hirv.

(The female of *C. villosus* is unknown)

4 Setae on abdominal tergites III-IV and on scutellum usually dense and uniformly distributed; numerous paratergital setae on most abdominal segments (e.g. Fig. 76_2) (Subgenus *Cricotopus*, in part-*tibialis*-group) 5

Setae on abdominal tergites III and IV not uniformly distributed, some areas lacking setae (e.g. Fig. 96); paratergital setae less abundant or absent 10

5 131–208 dorsocentral setae present (Fig. 76_1) .... *cumulatus* Hirv. (Fig. 76–78)

Number of dorsocentral setae much lower (e.g. Fig. $85_{1,3}$) 6

6 First tarsomere of p_1 with sensillae chaeticae situated on its basal half (rarely its basal 3/5); median antepronotal setae absent 7

This tarsomere with sensillae chaeticae situated on its basal ⅔ (rarely its basal 3/5); median antepronotal setae sometimes present 9

7 Setae of abdominal tergites somewhat reduced anteriorly (Fig. 83_4) ....
.... *gelidus* (Kieff.)(Fig. 83)

Setae of abdominal tergites uniformly distributed (Fig. 80_6) 8

8 Seminal capsules 150–210 μm long (Fig. 81_1); antenna with one preapical seta (Fig. 81_3)...
.... *ephippium*(Zett.) (Fig. 79–81)

Seminal capsules 140–160 μm long (Fig. 84_4); antenna without preapical seta (Fig. 84_7)....
.... *lestralis* (Edw.) (Fig. 84)

9 Median antepronotal setae present (Fig. 91_1) .... *polaris* Kieff. (Fig. 91, 92)

These setae usually absent (when present, this species cannot be differentiated with certainty from previous one) .... *tibialis* (Meig.) (Fig. 85–87)

10 Tarsi of p_2 and p_3 quite short (BV_{2-3} greater than 4.5); spermathecal ducts straight, seminal capsules elongate ovoid (Fig. 154_{10}) (Subgenus *Cricotopus*, in part-*caducus*-group) ....
.... *caducus* Hirv. (Fig. 152, 154)

Tarsi longer (BV_{2-3} less than 4.0); spermathecal ducts often strongly curved 11

11 Gonocoxite IX flat (Fig. 128_4); lateral setae on tergites III-IV in many rows (Fig. 128_7) (Subgenus *Nostococladius*) .... *lygropis* Edw. (Fig. 128)

Gonocoxite IX somewhat swollen (e.g. Fig. 110) (Subgenus *Cricotopus*, in part) 12

12 Spermathecal ducts curved and/or convoluted, when seminal capsules small (less than 90 μm) abdominal tergites and/or legs with pale markings 13

Spermathecal ducts usually straight, if curved (*C. pallidipes*) seminal capsules very small (about 60 μm) and rounded and legs and abdominal tergites unicolorous (Fig. 146) 30

13 Median setae of each abdominal tergite in one row or only one seta between MD_2 (Fig. 138_2, 140_2); some tergites pale, tibiae ringed (*festivellus*-group) 14

Median setae on each abdominal tergite in double longitudinal row; when these rows incomplete, many setae between MD_2(Fig. 96_2) 16

14 Abdominal tergites I and II pale, tergite II at most with dark spots laterally(Fig. 140_4) ....
.... *albiforceps* (Kieff.) (Fig. 140)

Pigmentation pattern different 15

Adult females (continued)

15 Abdominal tergites I, V and VI usually mostly pale(Fig. 137$_4$); in dark individuals only tergite I and anterior part of V pale .... *festivellus* (Kieff.) (Fig. 130, 136, 137)

Only tergite I pale (Fig. 138$_4$)............................ *flavocinctus* (Kieff.) (Fig. 138)

16 Seminal capsules pear-shaped (e.g. Fig. 98$_4$); legs and tergites either entirely dark or tergites I and II somewhat lighter than others; lateral setae present, often in many rows (*fuscus*-group)..17

Seminal capsules oval or rounded; legs and tergites often with pale markings 19

17 Paratergital setae absent (Fig. 96$_6$); first tarsomere of p$_2$ and p$_3$ each with 16–23 sensillae chaeticae; LR$_1$ 0.57–0.64.................................... *pirifer* Hirv. (Fig. 96, 104)

Paratergital setae present posteriorly on abdominal segments (Fig. 96$_{2,4}$); first tarsomere of p$_2$ and p$_3$ usually with more than 20 (16–44) sensillae chaeticae each 18

18 LR$_1$ 0.61–0.66 .... *fuscus*(Kieff.) (Fig. 95, 96, 98)

LR$_1$ 0.66–0.68 .... *algarum* (Kieff.) (Fig. 96, 102)

19 Abdominal tergites all dark or tergite I and areas between other tergites somewhat lightened (Fig. 129$_2$); seminal capsules always oval (longer than wide); lateral setae of tergites usually farther from lateral and posterior margins of tergites III and IV (Fig. 129$_8$) (*cylindraceus*-group)..20

Usually two or three abdominal tergites pale; when all tergites dark, seminal capsules rounded and no longer than wide (Fig. 122$_3$); rows of lateral setae on tergites III and IV very close to lateral and posterior margins of tergites (e.g. Fig. 112$_4$) (*tremulus*-group)... 22

20 Anterior tarsi usually entirely dark, occasionally an indistinct ring on tibiae; first tarsomere of p$_2$ with 14–21 sensillae chaeticae, that of p$_3$ with 12–18 sensillae chaeticae............. .... *coronatus* Hirv. (Fig. 130, 135)

Anterior tibiae with a distinct white ring..21

21 First tarsomere of p$_2$ with 51–75 sensillae chaeticae, that of p$_3$ with 50–83 sensillae chaeticae .... *cylindraceus* (Kieff.) (Fig. 129, 130)

First tarsomere of p$_2$ with 10–25 sensillae chaeticae, that of p$_3$ with 8–25 sensillae chaeticae .... *patens* Hirv. (Fig. 132, 133)

22 Anterior tarsi ringed 23

Anterior tarsi uniformly dark...26

23 Only second tarsomere of p$_1$ pale........................ *pulchripes* Verr. (Fig. 109, 110)

Second tarsomere and at least basal half of third tarsomere of p$_1$ pale..................24

24 Median antepronotal setae usually present; seminal capsules oval and without a neck-part (Fig. 108$_5$); LR$_1$ 0.66–0.70 .... *septentrionalis* Hirv. (Fig. 107, 108)

With another combination of characters; median antepronotal setae absent; LR$_1$ usually less 25

25 Seminal capsules round and with a short but distinct neck-part (Fig. 113$_6$)............... .... *tremulus* (L.) (Fig. 111–113)

Seminal capsules oval and without a distinct neck-part (Fig. 116$_9$) .... *claripes* Hirv. (Fig. 116)

26 Tergite IV pale..27

Tergite IV dark 28

27 Abdominal tergites I and IV pale.......................... *beckeri* Hirv. (Fig. 124, 125)

Abdominal tergites I, IV and V with pale markings (Fig. 126$_2$) .... *triannulatus* (Macq.) (Fig. 126)

28 Seminal capsules oval; abdominal tergites I and II usually more or less pale............. .... *tristis* Hirv. (Fig. 117)

Seminal capsules rounded 29

Adult females (continued)

29 Abdominal tergites I and II usually entirely pale (Fig. 119_2); first tarsomere of p_2 with 11–27 sensillae chaeticae, first tarsomere of p_3 with 10–24 sensillae chaeticae .... *curtus* Hirv. (Fig. 118–119)

All abdominal tergites dark or I or I and II pale; first tarsomere of p_2 with 8–14 sensillae chaeticae, that of p_3 with 8–13 .... *annulator* Goetgh. (Fig. 122)

30 LR_1 0.45–0.57; legs and abdominal tergites uniformly colored; spermathecal ducts straight (*magus*-group) .... *magus* Hirv. (Fig. 106)

LR_1 greater than 0.5 31

31 Abdominal tergites I and IV pale and tibiae ringed; seminal capsules usually over 100μm long, when as small as in following species group, fore edge of tergite II brighter pale than in those species (*trifascia*-group) 32

Abdominal tergites and legs uniformly colored, or abdominal tergites I and IV pale and tibiae ringed; seminal capsules small, no more than 80 μm long, rounded and with a short neck (*bicinctus*-group) 33

32 Seminal capsules over 100 μm (Fig. 147_6); first tarsomere of p_2 and p_3 with 40–50 sensillae chaeticae on basal half .... *trifascia* Edw. (Fig. 147, 148)

Seminal capsules no more than 80 μm long (Fig. 151_7); first tarsomere of p_2 with 10–14 sensillae chaeticae on basal 2/5, and about same number on basal ¼-⅓ of first tarsomere of p_3 .... *similis* Goetgh. (Fig. 151)

33 Spermathecal ducts curved (Fig. 146_9); abdominal tergites unicolorous (Fig. 146_3) .... *pallidipes* Edw. (Fig. 146)

Spermathecal ducts straight; abdominal tergites I and IV pale 34

34 Setae on gonocoxite IX up to 60 μm long (Fig. 142_5), at least one seta longer than 20 μm. .... *bicinctus* (Meig.) (Fig. 142)

Setae on gonocoxite IX about 20 μm long (Fig. 144_9) .... *vierriensis* Goetgh. (Fig. 144)

35 Humeral setae absent (*brevipalpis*-group) .... *brevipalpis* Kieff. (Fig. 213, 214)

Humeral setae present 36

36 Median antepronotal setae present; preepisternal setae absent (Fig. 155_2); antenna without preapical setae; abdominal tergites with relatively dense setae (Fig. 155_4) (*dobrogicus*-group) .... *dobrogicus* Albu (Fig. 155, 156)

Median antepronotal setae usually absent; when present (one species) preepisternal setae present 37

37 Transverse rows of basal and marginal setae absent; median setae more or less separated from lateral setae (Fig. 158_2, 181_5); antenna without preapical setae (Fig. 158_5); pulvillae small, but distinct (*sylvestris*-group) 38

Transverse rows of basal and/or marginal setae present on abdominal tergites (e.g. Fig. 193_2); antenna usually with one preapical seta (Fig. 193_{10}); pulvillae present or absent 48

38 Scutellar setae less than 3 μm thick 39

Scutellar setae 4–5 μm thick 40

39 Seminal capsules oval (Fig. 158_6); first tarsomere of p_1 without sensillae chaeticae .... *ornatus* (Meig.) (Fig. 157, 158)

Seminal capsules more elongate (Fig. 170_4); first tarsomere of p_1 with about 12 sensillae chaeticae .... *relucens* Hirv. (Fig. 169, 170)

40 Lateral setae of abdominal tergites III and IV about ⅔ as long as median setae (e.g. Fig. 160_6) 41

Lateral setae of abdominal tergites III and IV distinctly shorter, about ⅓ as long as median setae 42

41 First tarsomere of p_3 with 47–74 sensillae chaeticae .... *laetus* Hirv. (Fig. 160, 162)

First tarsomere of p_3 with 90–141 sensillae chaeticae .... *pilitarsis* (Zett.) (Fig. 165–167)

Adult females (continued)

42 Abdominal tergite VIII somewhat pale, others very dark (Fig. 177_2); first tarsomere of p_2 and p_3 each with 31–32 sensillae chaeticae........................*glacialis* Edw. (Fig. 177)

Pigmentation otherwise..43

43 Abdominal tergites I and VII almost entirely pale, others entirely dark (Fig. 178_2); area between vittae light; first tarsomere of p_2 with 50–63 sensillae chaeticae, that of p_3 with 52–70 sensillae chaeticae ....*suspiciosus* Hirv. (Fig. 178, 179)

Pigmentation otherwise..44

44 Abdominal tergites IV and/or VII with some pigmentation, often in form of a dark transverse stripe, some of remaining tergites with some pale areas (Fig. 172_4); first tarsomere of p_2 with 32–55 sensillae chaeticae, that of p_3 with 34–53 sensillae chaeticae...*sylvestris* (Fabr.) (Fig. 171–173)

Abdominal tergites I, IV and VII almost entirely pale, others entirely dark.............45

45 Area between vittae pale (e.g. Fig. 181_2); tergite IV entirely pale or pigmented near MD_2 (Fig. 183_2)..46

At least median area between vittae dark (e.g. Fig. 187_4); tergite IV pale or pigmented near anterior edge of tergite 47

46 First tarsomere of p_2 with 79–90 sensillae chaeticae, that of p_3 with 75–89 sensillae chaeticae ....*trifasciatus* (Meig.) (large form) (Fig. 181, 182)

First tarsomere of p_2 with 31–45 sensillae chaeticae, that of p_3 with 31–45 sensillae chaeticae ....*trifasciatus* (Meig.) (small form) (Fig. 183)

47 First tarsomere of p_2 with 123–126 sensillae chaeticae, that of p_3 with 124–125 sensillae chaeticae ....*speciosus* Goetgh. (Fig. 187, 188)

First tarsomere of p_2 with 41–59 sensillae chaeticae, that of p_3 with 40–64 sensillae chaeticae ....*tricinctus* (Meig.) (Fig. 189)

48 Transverse rows of both basal and marginal setae usually present on tergites III-IV (Fig. 193_2); when basal setae absent, median setae paired; antenna with one preapical seta, pulvillae absent (*reversus*-group)..49

Tergites III-IV without transverse rows of basal setae; median setae in one row.........50

49 Preepisternal setae present; seminal capsules rounded and with a distinct neck-part (Fig. 193_{11})..*reversus* Hirv. (Fig. 192, 193)

Preepisternal setae absent; seminal capsules oval, the neck-part less distinct (Fig. 195_{11}) ....*perniger* (Zett.) (Fig. 192, 195)

50 Scutellar setae numerous, not arranged in a single row (Fig. 196_1); seminal capsules rounded, at least 80 μm long (Fig. 198_6); abdominal tergites unicolorous (Fig. 197_2) or tergites I and IV somewhat pale (Fig. 198_3); antenna with one preapical seta (*intersectus*-group) ....*intersectus* (Staeg.) (Fig. 196–198)

Scutellar setae usually in a single row (e.g. Fig. 201_3); seminal capsules usually oval; when rounded no more than 60 μm in diameter (without the neck-part); abdominal tergites unicolorous; antenna with or without preapical seta 51

51 Seminal capsules small (50–60 μm) and rounded; spermathecal ducts straight (Fig. 209) (?*obnixus*-group)...*obnixus* (Walk.) (Fig. 208, 209)

Seminal capsules oval; spermathecal ducts curved or convoluted (*laricomalis*-group)......52

52 Gonocoxite IX somewhat longer than wide (Fig. 203_1); pulvillae absent...*arcuatus* Hirv. (Fig. 201–203)

Gonocoxite IX about as long as wide; small pulvillae present...........................53

53 Antenna without preapical seta (Fig. 204_{10}); seminal capsules 75–90 μm long (Fig. 204_{11}) ....*obtusus* Hirv. (Fig. 204)

Antenna with preapical seta (Fig. 205_{12}); seminal capsules 110–114 μm long (Fig. 206) ....*laricomalis* Edw. (Fig. 201, 205, 206)

Pupae (40 species)

1 Frontal setae on prefrons (anterior to middle of antennal bases—Fig. 79_3) (Subgenus *Cricotopus*, in part) 2

Frontal setae on frontal apotome or absent 15

2 Thoracic horn short, without spinules and distinctly rounded apically (Fig. 113_3) (*tremulus*-group, in part) .... *tremulus* (L.) (Fig. 113, 114)

Thoracic horn with spinules or absent 3

3 D$_4$-seta of segment VIII displaced laterally, located close to L$_4$ and appearing as a fifth L-seta (e.g. Fig. 120_2); shagreen always separated into anterior and posterior fields and kidney- or crescent-shaped (*tremulus*-group, in part) 4

D$_4$-seta of segment VIII located somewhat medial from L-setae (Fig. 93_3, 97_{7-8}) 5

4 L$_4$ of segment VIII distinctly larger than other L-setae of that segment (Fig. 120_2) .... *curtus* Hirv. (in part) (Fig. 120)

L$_4$ of segment VIII no larger than the other L-setae of that segment .... *triannulatus* (Maeq.) (in part) (Fig. 126)

5 L$_4$ of segment VIII equal to or longer than other L-setae of that segment (Fig. 87_8, 93_3); shagreen on abdominal tergites usually more or less separated into anterior and posterior fields; if widely separated, anterior field usually rectangular and never crescent-shaped (e.g. Fig. 87_6) 6

L$_4$ of segment VIII equal to or smaller than the other L-setae of that segment; shagreen usually widely separated into anterior and posterior fields, these usually crescent-shaped (e.g. Fig. 140_7); if fields united, a relatively large spinule-free area occurs near posteromedian muscle marks (MD$_2$) (Fig. 137_{11}) 9

6 Shagreen continuous, not interrupted (Fig. 75_{4-5}); pedes spurii B not strongly developed .... *pilosellus*-group (Fig. 74, 75) (The pupae of two species in this group are known, *C. pilosellus* and *C. pilidorsum*, but no characters are known for distinguishing them from one another.)

Shagreen usually distinctly separated into anterior and posterior fields; if shagreen uninterrupted, dorsal region of thorax with faintly spined wrinkles (Fig. 82) (*tibialis*-group) ... 7

7 Dorsal region of thorax with faintly spined wrinkles (Fig. 82); accessory tubercle of antennal sheath (near pedicel) nearly as long as wide (similar to Fig. 130_3) .... *ephippium* (Zett.) (Fig. 79, 81, 82)

Dorsal region of thorax smooth; accessory tubercle of antennal sheath barely discernible . 8

8 Dc$_2$ near Dc$_1$ (Fig. 93_1); anterior field of shagreen scarcely extends anterolaterally from anteromedian muscle marks (MD$_1$) (Fig. 93_4) .... *polaris* Kieff. (Fig. 93)

Dc$_2$ near Dc$_3$ and Dc$_4$ (Fig. 87_9); anterior field of shagreen usually extends anterolaterally from MD$_1$ (Fig. 87_6) .... *tibialis* (Meig.) (Fig. 87, 90)

9 Pedes spurii B well developed on abdominal segments II and III; shagreen always separated into anterior and posterior fields (*cylindraceus*-group) 10

Pedes spurii B usually only well developed on segment II; if also on segment III, shagreen not separated into anterior and posterior fields (Fig. 137_{11}) 12

10 Exuviae entirely pale; no accessory tubercle on antennal sheath; abdominal segment VII with 3–4 L-setae .... *coronatus* Hirv. (Fig. 135)

Exuviae either moderately pigmented or a few abdominal segments very dark; abdominal segment VII with 3 L-setae 11

11 All abdominal segments moderately dark; accessory tubercle of antennal sheaths well developed (Fig. 130_3) .... *cylindraceus* (Kieff.) (Fig. 130)

Tergites II–V very dark (Fig. 133_7); accessory tubercle on antennal sheaths barely discernible .... *patens* Hirv. (Fig. 133)

12 Thoracic horn absent and anterior fields of shagreen crescent-shaped and not extending to anterolateral edges of tergites (Fig. 154_7) (*caducus*-group) .... *caducus* Hirv. (Fig. 154)

Thoracic horn usually present; if absent, anterior fields of shagreen extend over MD$_1$ to edges of tergites (Fig. 138_{11}) (*festivellus*-group) 13

Pupae (continued)

13 Thoracic horn absent . . . . *flavocinctus* (Kieff.) (Fig. 138)

Thoracic horn present. 14

14 Shagreen distinctly separated into anterior and posterior fields . . . . *albiforceps* (Kieff.) (Fig. 140)

Shagreen not distinctly separated into anterior and posterior fields, spinule-free area usually present near MD$_2$ (Fig. 137$_{11}$) . . . . *festivellus* (Kieff.) (Fig. 136, 137)

15 Most mesal of 3 anal macrosetae (on each side) distinctly shorter than other 2 setae (Fig. 148$_4$); tergites VII–VIII with strong shagreen (Subgenus *Cricotopus*, in part—*trifascia*-group) . . . . *trifascia* Edw. (Fig. 147, 148)

Anal macrosetae all about equally long; no strong shagreen on tergites VII–VIII (except *C. brevipalpis*—Fig. 214) 16

16 Frontal setae, pedes spurii B and thoracic horns absent (Subgenus *Cricotopus*, in part—*magus*-group) . . . . *magus* Hirv. (Fig. 106)

One or more of the above structures present 17

17 D$_4$-seta of segment VIII displaced laterally, inserted elose to L$_4$ and appearing as a fifth L-seta (e.g. Fig. 120$_2$); anterior fields of shagreen always separate from posterior fields and kidney- or cresent-shaped (Subgenus *Cricotopus*, in part—*tremulus*-group, in part) 18

D$_4$-seta of segment VIII located somewhat medial from L-setae (Fig. 93$_3$, 97$_{7-8}$). 21

18 Frontal setae absent 19

Frontal setae present 20

19 Pedes spurii B present on abdominal segments II and III (Fig. 117$_{12}$). . . . . *tristis* Hirv. (Fig. 117)

Pedes spurii B present only on segment II (Fig. 122$_{12}$) . . . . *annulator* Goetgh. (Fig. 122)

20 L$_4$ of segment VIII distinctly larger than other L-setae of that segment (Fig. 120$_2$) . . . . *curtus* Hirv. (in part) (Fig. 120)

L$_4$ of segment VIII no larger than other L-setae . . . *triannulatus* (Macq.) (in part) (Fig. 126)

21 Anterior and posterior fields of shagreen widely separated from one another (Subgenus *Cricotopus*, in part) 22

Shagreen of abdominal tergites usually not divided into anterior and posterior fields; when divided, anterior field extends anterolaterally over MD$_1$ to anterior corner of tergite (Fig. 195$_7$, 199$_2$) (Subgenus *Isocladius*). 26

22 Pedes spurii B present on abdominal segments II and III; thoracic horn present; L$_4$ of segment VIII not larger than the other L-setae of that segment (*bicinctus*-group) 23

Pedes spurii B present on segement II but not on segment III; L$_4$-seta of segment VIII somewhat larger than other L-setae (*fuscus*-group) 24

23 Thoracic horn 15–20 µm wide (Fig. 142$_{11}$). . . . . *bicinctus* (Meig.) (Fig. 142)

Thoracic horn 45–50 µm wide (Fig. 144$_{10}$) . . . . *vierriensis* Goetgh. (Fig. 144)

24 Three L-setae on each side of abdominal segment VIII; shagreen on tergite V not separated into anterior and posterior fields (Fig. 97$_1$). . . . . *pirifer* Hirv. (Fig. 97)

Four L-setae on each side of segment VIII: shagreen separated into anterior and posterior fields on segment V (Fig. 97$_{2-3}$). 25

25 Thoracic horn present (Fig. 97$_5$) . . . . *fuscus* (Kieff.) (Fig. 97)

Thoracic horn absent . . . . *algarum* (Kieff.) (Fig. 97)

26 Tergites VII and VIII with strong shagreen (Fig. 214$_4$) or row of hooklets on conjunctive II/III interrupted medially (*brevipalpis*-group). . . . . *brevipalpis* Kieff. (Fig. 213, 214)

Tergites VII and VIII with at most weak shagreen; transverse row of hooklets on conjunctive II/III uninterrupted 27

27 Shagreen on tergites II-V more or less uniformly distributed (Fig. 175$_{1-2}$); D$_3$-seta located somewhat medial of line between D$_2$ and D$_4$ (Fig. 174) (*sylvestris*-group). 28

Shagreen on tergites III-V reduced laterally and sometimes separated into anterior and posterior fields (e.g. Fig. 195$_7$); D$_3$-seta inserted close to the line between D$_2$ and D$_4$. 35

Pupae (continued)

28 Thoracic horn dark, 20–55 μm wide, 340–360 μm long and covered with very small spinules (Fig. 158_4) .... *ornatus* (Meig.) (Fig. 157, 158)

Thoracic horn usually smaller and lacking spinules, at most weakly darkened 29

29 Frontal setae 3–5 μm thick 30

Frontal setae 2–3 μm thick 31

30 Pedes spurii B present on abdominal segment II; thoracic horn 220–330 μm long, colorless or uniformly lightly pigmented; at most 3 L-setae on segment VII .... *sylvestris* (Fabr.) (Fig. 172, 174, 175)

Pedes spurii B absent; thoracic horn 100–230 μm long, often somewhat swollen basally and occasionally somewhat pigmented and wrinkled (Fig. 184_2); 4 L-setae often present on segment VII .... *trifasciatus* (Meig.) (small form) (Fig. 184, 185)

31 Pedes spurii B present on segment II (Fig. 163); thoracic horn 250–380 μm long (Fig. 160_3) .... *laetus* Hirv. (Fig. 160, 163)

Pedes spurii B absent; thoracic horn usually shorter 32

32 Length of exuviae 4.0–5.0 mm; frontal setae 2–3 μm thick; 3 L-setae on abdominal segment VII .... *tricinctus* (Meig.) (Fig. 185, 190)

Length of exuviae 5.0–6.5 mm 33

33 150–200 hooklets on conjunctive II/III .... *relucens* Hirv. (Fig. 169, 170)

100–140 hooklets on conjunctive II/III 34

34 Frontal setae about 2.0 μm thick .... *pilitarsis* (Zett.) (Fig. 167)

Frontal setae 2.5–3.0 μm thick .... *suspiciosus* Hirv. (Fig. 179)

35 Thoracic horn lacking spinules and blunt or rounded apically 36

Thoracic horn with spinules; if these are weak, the horn is pointed apically 39

36 Pedes spurii B absent; thoracic horn quill-shaped (Fig. 208_5) (?*obnixus*-group) .... *obnixus* (Walk.) (Fig. 208)

Pedes spurii B present on abdominal segment II (*laricomalis*-group) 37

37 Thoracic horn rounded apically and often strongly constricted basally (Fig. 205_5) .... *laricomalis* Edw. (Fig. 205)

Thoracic horn blunt apically and trimmed with minute hair-like spinules (Fig. 202_5, 204_5) 38

38 Suture margin very weakly granulated and wrinkled .... *arcuatus* Hirv. (Fig. 202)

Suture margin smooth (distinction from previous species questionable; additional material may yield some differences in size of thoracic horn) .... *obtusus* Hirv. (Fig. 204)

39 Pedes spurii B present on segment II and sometimes granulated; also present but very weak on segment III; thoracic region wide and strongly granulated dorsally (Fig. 199) (*intersectus*-group) .... *intersectus* (Staeg.) (Fig. 199)

Pedes spurii B present only on segement II; thoracic region narrow dorsally and relatively weakly granulated (*reversus*-group) 40

40 Thoracic horn with distinct spinules and more than 150 μm long (Fig. 193_5) .... *reversus* Hirv. (Fig. 193)

Spinules on thoracic horn barely distinguishable, horn much shorter (Fig. 195_5) .... *perniger* (Zett.) (Fig. 195)

Larvae (26 spp.)

1 Pecten epipharyngis composed of three nearly equal-sized scales (e.g. Fig. 88_3) (Subgenus *Cricotopus*) 2

Pecten epipharyngis a single conical scale, often with a notch on each side (the lateral scales are reduced and fused with the median scale) (e.g. Fig. 176_3) (Subgenus *Isocladius*) ... 16

2 Median tooth of mentum at most 2½ times as wide as a first lateral tooth, often much narrower; premandibles simple or bifid 3

Median tooth of mentum 3 or more times as wide as a first lateral tooth; premandibles simple 10

3 Premandibles simple (*tremulus*-group) 4

Premandibles bifid 7

4 Premandibular brush present, although small (Fig. 115_5); abdominal setae simple, thick and long .... *tremulus* (L.) (Fig. 115)

Premandibular brush absent; several abdominal segments with setal tufts 5

5 Antennal ratio 1.3–1.5 .... *annulator* Goetgh. (Fig. 123)

Antennal ratio 1.5–1.8 6

6 Outer mandibular margin nearly smooth (Fig. 121_4) .... *curtus* Hirv. (Fig. 121)

Outer mandibular margin crenulate (Fig. 127_5) .... *triannulatus* (Macq.) (Fig. 127)

7 Premandibular brush present, composed of small spiny appendages (Fig. 88_3); setal tufts present on abdominal segments I–VIII (*tibialis*-group) .... *tibialis* (Meig.) (Fig. 88)

Premandibular brush absent; abdominal segments I–VI with setal tufts or occasionally strong simple setae (*fuscus*-group) 8

8 Median tooth of mentum 1.2–1.4 times as wide as a first lateral tooth (Fig. 99_5) .... *fuscus* (Kieff.) (Fig. 99)

Median tooth of mentum 1.5–1.7 times as wide as a first lateral tooth 9

9 Setal tufts each with 5–12 setae (rarely 2) .... *algarum* (Kieff.) (Fig. 103)

L_4 usually a 2–4 branched seta (rarely a small setal tuft) (Fig. 105_{11}) .... *pirifer* Hirv. (Fig. 105)

10 First and second lateral teeth of mentum small and partially fused with median tooth (Fig. 149_1) (*trifascia*-group) .... *trifascia* Edw. (Fig. 149, 150)

First and second lateral teeth of mentum not partially fused with median tooth 11

11 Inner margin of mandible serrated (Fig. 143_5) (*bicinctus*-group, in part) .... *bicinctus* (Meig.) (Fig. 143)

Inner margin of mandible smooth 12

12 Galea with only a few distally pinnate lamellae (Fig. 145_{11}) (*bicinctus*-group, in part) .... *vierriensis* Goetgh. (Fig. 145)

Galea with many distally pinnate lamellae (e.g. FIg. 139_{12}) 13

13 Lateral teeth of mentum all about equally large 14

Second lateral teeth of mentum distinctly smaller than third lateral teeth (Fig. 134_{4-5}) ... 15

14 Antennal ratio 2.4 (*cylindraceus*-group, in part) .... *cylindraceus* (Kieff.) (Fig. 131)

Antennal ratio about 1.5 (*festivellus*-group, in part) .... *albiforceps* (Kieff.) (Fig. 141)

15 Galea with at most two rows of distally pinnate lamellae (Fig. 134_{13}) (*cylindraceus*-group, in part) .... *patens* Hirv. (Fig. 134)

Galea with three rows of distally pinnate lamellae (Fig. 139_{12}) (*festivellus*-group, in part) .... *flavocinctus* (Kieff.) (Fig. 139)

16 Premandibles bifid (*sylvestris*-group) 17

Premandibles simple 22

17 Abdominal segments I–VII with setal tufts 18

Abdominal segments I–VI with setal tufts, segment VII with at most a double seta 19

Larvae (continued)

18 Both sense pits of basal antennal segment near ring organ (Fig. 159_2) .... *ornatus* (Meig.) (Fig. 159)

One sense pit near ring organ, other near middle of basal antennal segment (Fig. 164_2) .... *laetus* Hirv. (Fig. 164)

19 Apical tooth of small claws of anterior parapods not strikingly larger than subapical teeth (Fig. 176_{11}) .... *sylvestris* (Fabr.) (Fig. 176)

Apical tooth of these claws much larger than subapical teeth (Fig. 191_{11}) 20

20 Antennal ratio of mature larvae 1.4–1.7 .... *tricinctus* (Meig.) (Fig. 191)

Antennal ratio of mature larvae 1.7–2.0 21

21 Antenna about 6 times as long as wide (Fig. 180_3) .... *suspiciosus* Hirv. (Fig. 180)

Antenna 5.0–5.5 times a long as wide (Fig. 186_2) .... *trifasciatus* (Meig.) (Small form) (Fig. 186)

22 SI simple (Fig. 210_4) 23

SI bifid (e.g. Fig. 207_3) 24

23 Antenna more than twice as long as wide; seta interna of mandible present (Fig. 210) .... *elegans* Joh. (Fig. 210)*

Antenna no longer than wide (Fig. 215_8); seta interna of mandible absent (Fig. 215_6) (*brevipalpis*-group) .... *brevipalpis* Kieff. (Fig. 215)

24 Setal tufts of abdomen each composed of about 10 setae, the longest seta about twice as long as corresponding abdominal segment (?*laricomalis*-group) ..... *laricomalis* Edw. (Fig. 207)

Setal tufts each about as long as corresponding abdominal segment 25

25 Setal tufts on abdominal segments I–VII each composed of 20–50 setae (Fig. 194_7) (?*reversus*-group) .... *reversus* Hirv. (Fig. 194)

Setal tufts on segments I–VI each composed of 20–30 setae (Fig. 200_7); tuft on segment VII either absent or composed of fewer than 10 setae (*intersectus*-group) .... *intersectus* (Staeg.) (Fig. 200)

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* This species belongs to the *obnixus*-group and probably is synonymous with *C. obnixus* (Walk.).

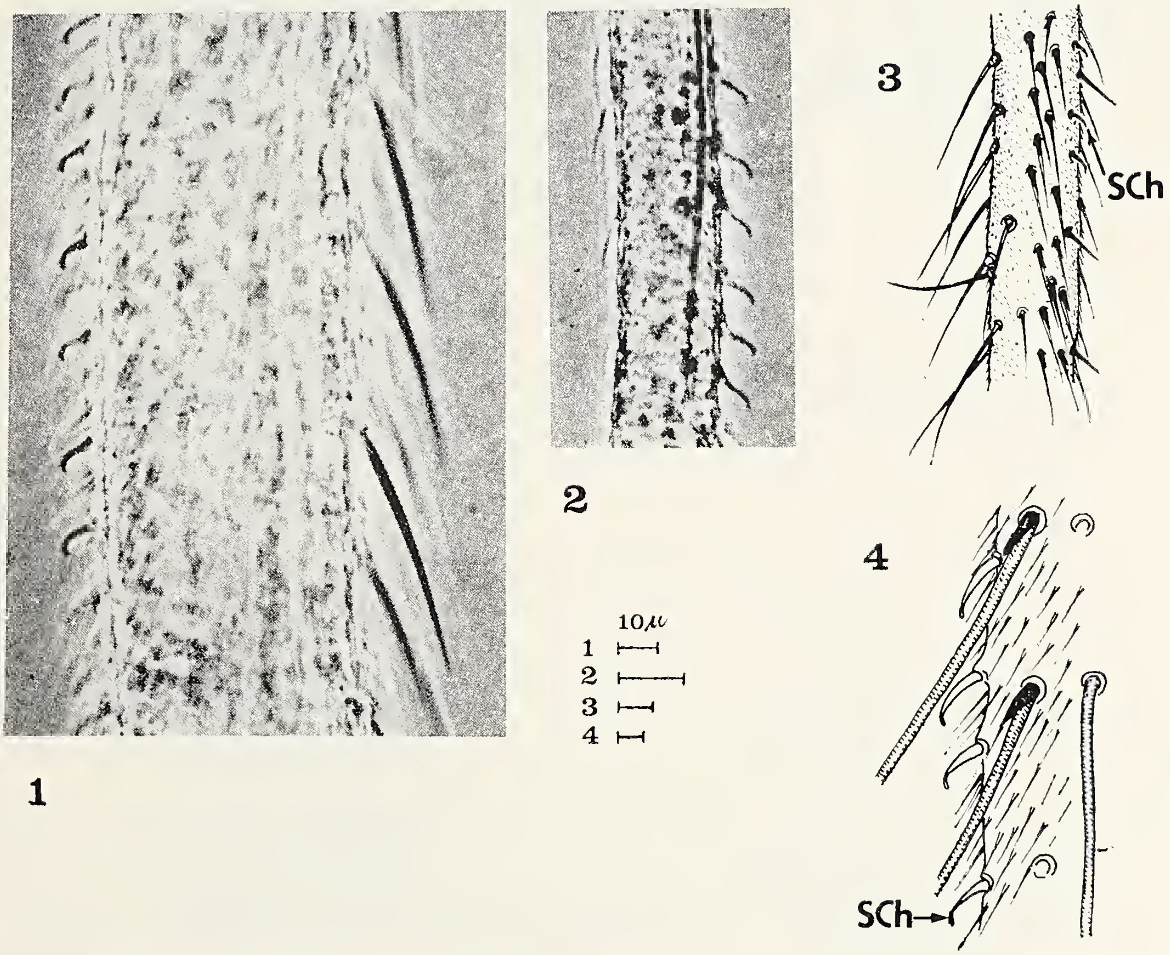


Figure 5. *Paracladius conversus* (Walk.) ♂ basitarsis of p_3 in phase contrast, sensillae chaeticae on left (1); *Cricotopus caducus* Hirv. ♀, basitarsis of p_1 in phase contrast, sensillae chaeticae on right (2); *Cricotopus sylvestris* (Fabr.) ♂, basitarsis of p_3 (3); same of *P. conversus* (4). SCh sensilla chaetica.

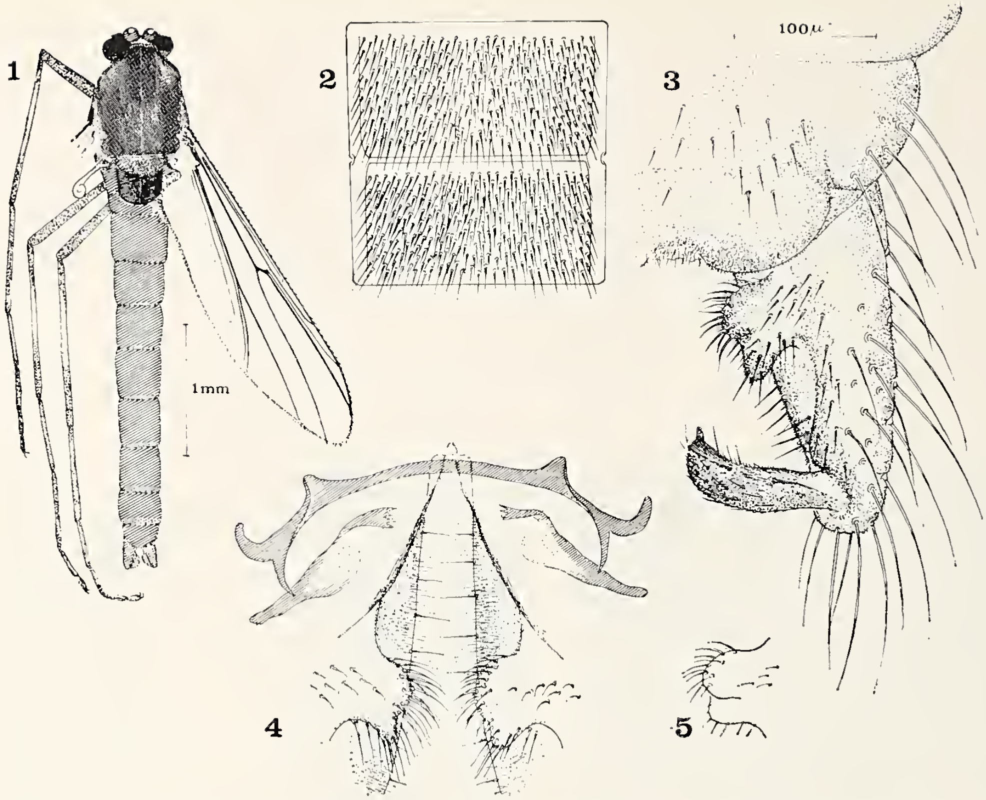


Figure 72. *Cricotopus* (*C.*) *villosus* Hirv., adult. ♂ (1); chaetotaxy scheme for abdominal tergites III and IV of ♂ (2); hypopygium of ♂ (3); aedeagal lobe and phallapodeme of hypopygium (4); inferior volsella with example from Spitzbergen (5). Scale of drawings 3=4–5.

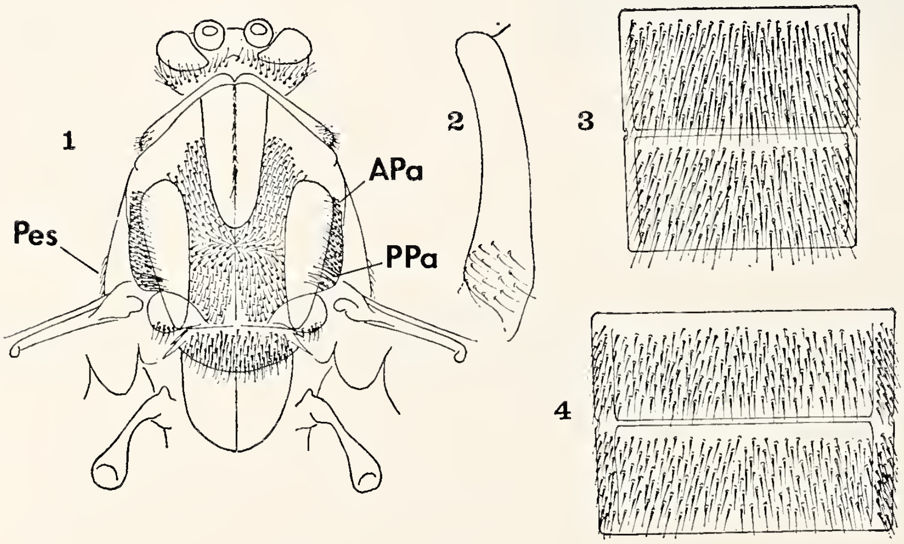


Figure 73. *Cricotopus* (*C.*) *pilosellus* Brund., adult. Chaetotaxy scheme for head and thorax, dorsal (1); antepronotum, lateral (2); chaetotaxy scheme for abdominal tergites III and IV of ♂ (3); same (and Pts) of ♀ (4).—APa anterior prealars, Pes preepisternal setae, PPa posterior prealars.

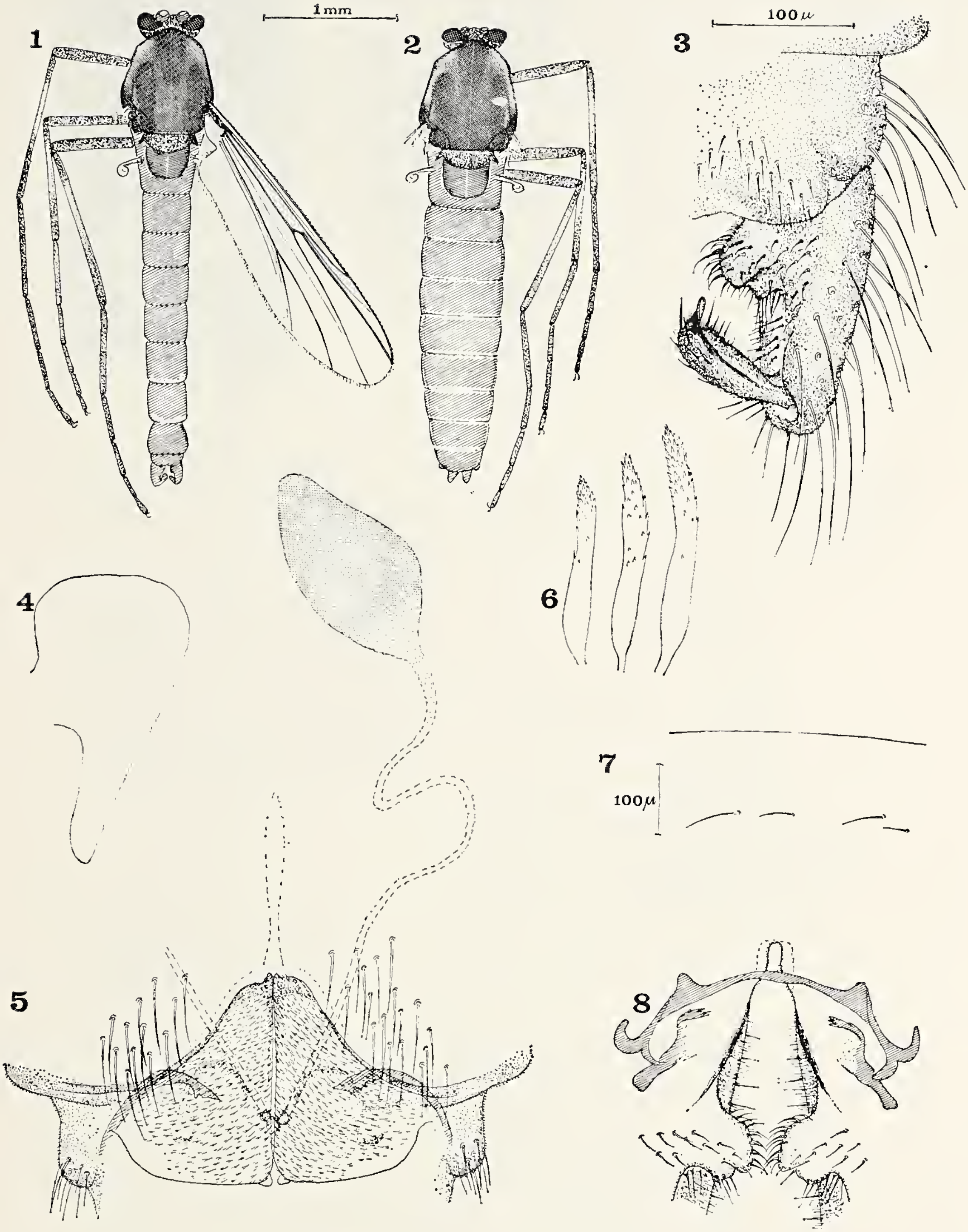


Figure 74. *Cricotopus* (*C.*) *pilosellus* Brund., adult, pupa. ♂ (1); ♀ (2); hypopygium of ♂ (3); cercus (4); spermatheca and outer genitalia of ♀ (5); thoracic horn of pupa (6); arrangement and size relationship of Dc setae of pupa (7); aedeagal lobe and phallapodeme of hypopygium of ♂ (8). Scale of drawings 1=2; 3=4−6, 8.

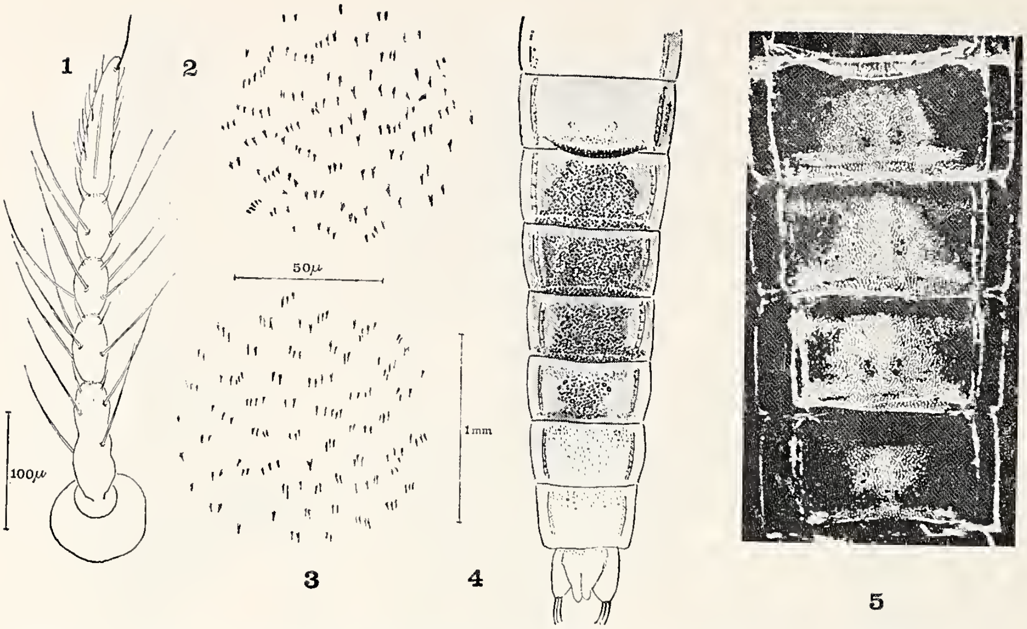


Figure 75. *Cricotopus* (*C.*) *pilosellus* Brund., adult, pupa. Antenna of ♀ (1); spinules of anterior edge of abdominal sternite III (2); shagreen and pigmentation of abdominal segments of pupa (4); shagreen of segments III-VI, dark field photography (5). *Cricotopus* (*C.*) *pilidorsum* Hirv. spinules of anterior edge of abdominal sternite III (3).

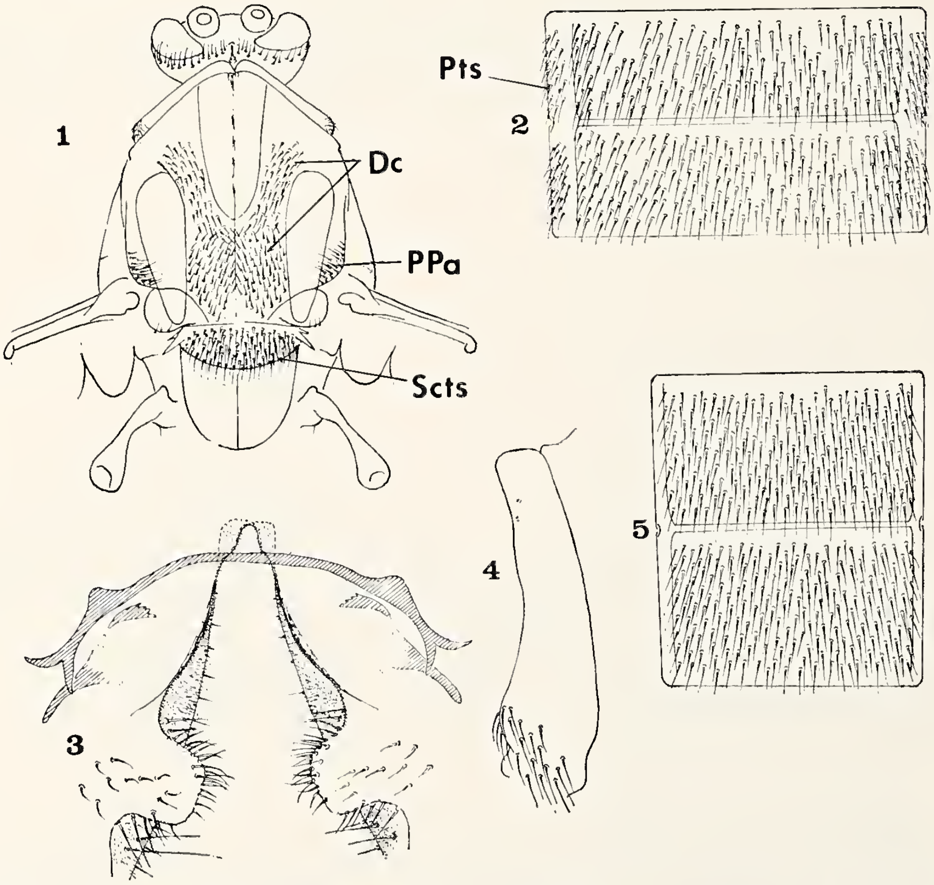


Figure 76. *Cricotopus* (*C.*) *cumulatus* Hirv., adult. Chaetotaxy scheme for head and thorax, dorsal of ♀ (1); same for abdominal tergites III and IV (as well as Pts) of ♀ (2); aedeagal lobe and phallapodeme of hypopygium of ♂ (3); antepronotum, lateral (4); chaetotaxy scheme for abdominal tergites III and IV of ♂ (5). — Dc dorsocentrals, PPa posterior prealars, Pts paratergital setae, Scts scutellar setae.

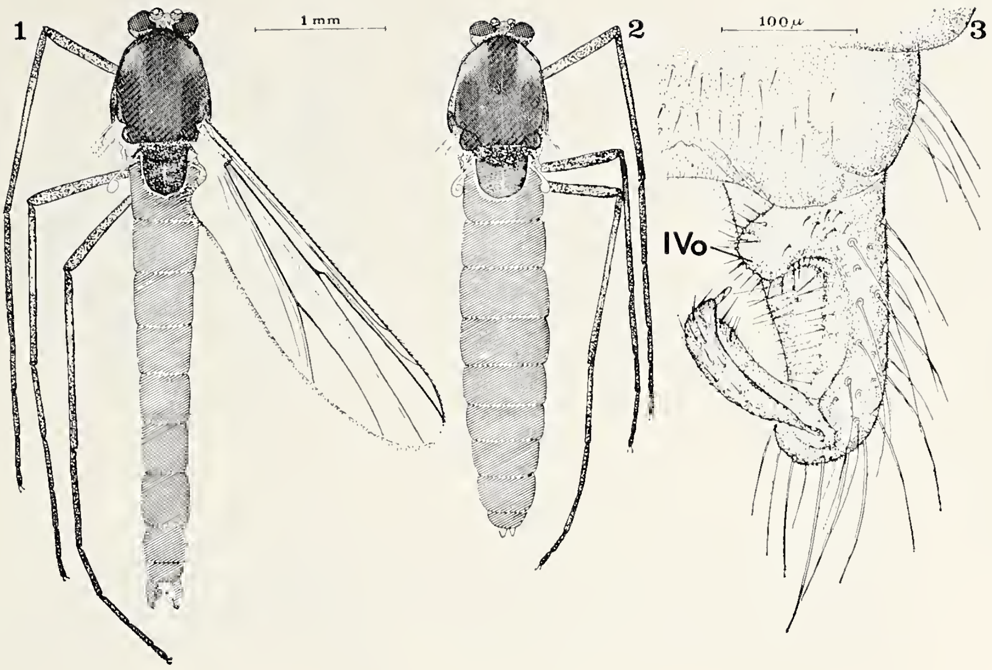


Figure 77. *Cricotopus* (*C.*) *cumulatus* Hirv., adult. ♂ (1); ♀ (2); hypopygium of ♂ (3).—IVo inferior volsella.

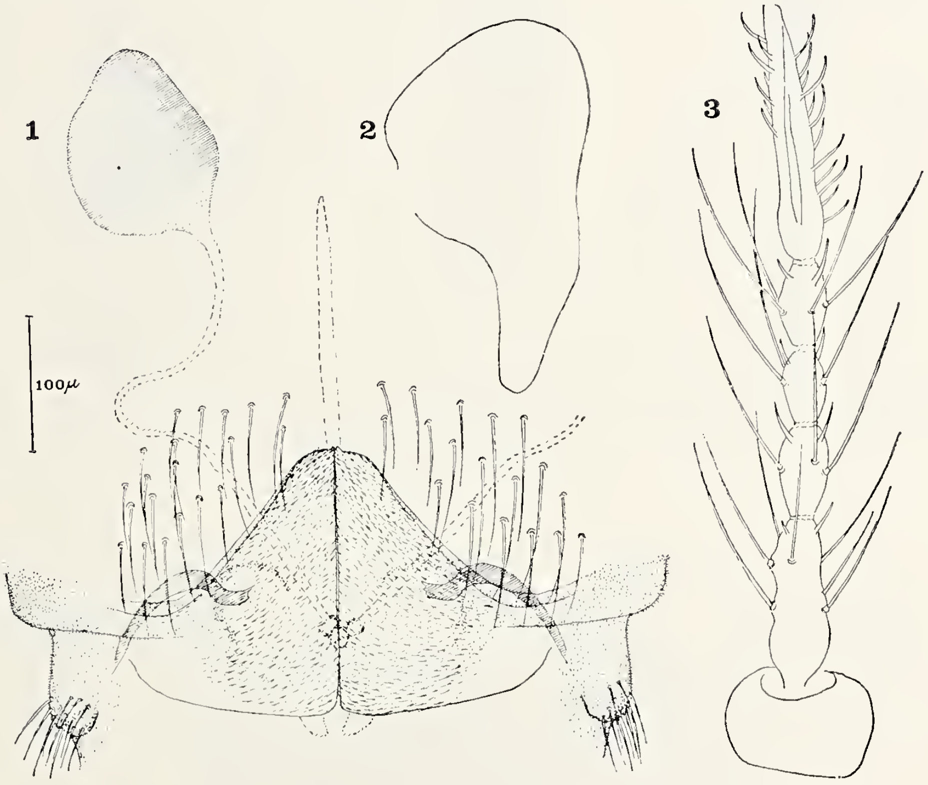


Figure 78. *Cricotopus* (*C.*) *cumulatus* Hirv., adult ♀. Spermatheca and outer genitalia (1); cercus (2); antenna (3).

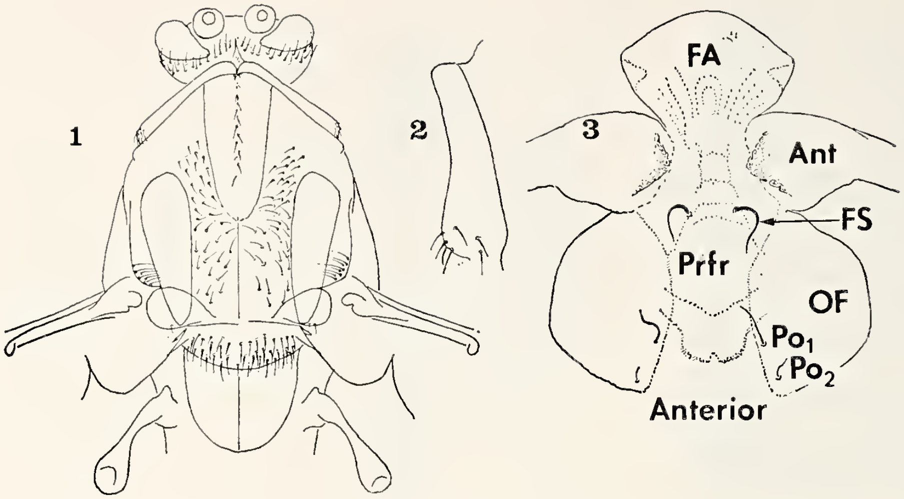


Figure 79. *Cricotopus* (*C.*) *ephippium* (Zett.). Chaetotaxy scheme for head and thorax of adult, dorsal (1); antepronotum, lateral (2); head region of pupal exuvium (3).—Ant proximal part of antennal sheath (hump in region of pedicel punctuate), FS frontal setae, FA frontal apotome, OF ocular field, Po_{1-2} postorbitals, Prfr prefrons.

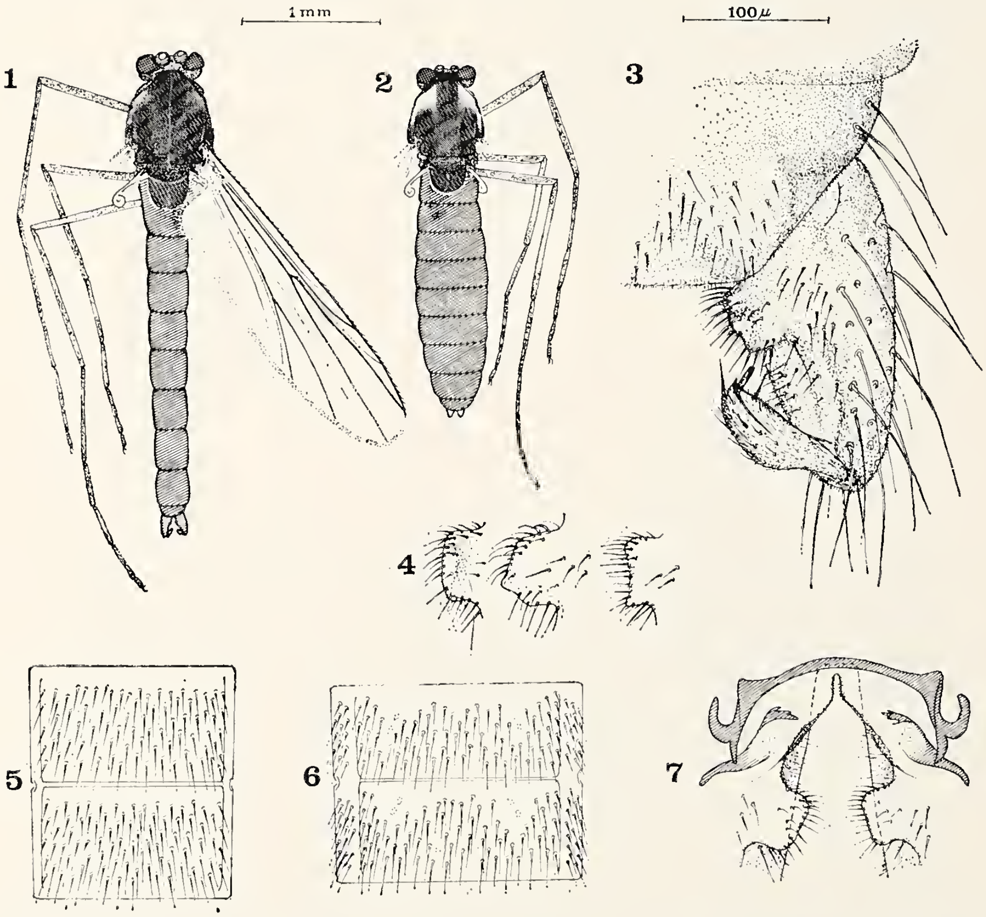


Figure 80. *Cricotopus* (*C.*) *ephippium* (Zett.), adult. ♂ (1); ♀ (2); hypopygium of ♂ (3); variation of inferior volsella (4); chaetotaxy scheme for abdominal tergites III and IV of ♂ (5); same of ♀ (with Pts) (6); aedeagal lobe and phallapodeme of hypopygium (7).

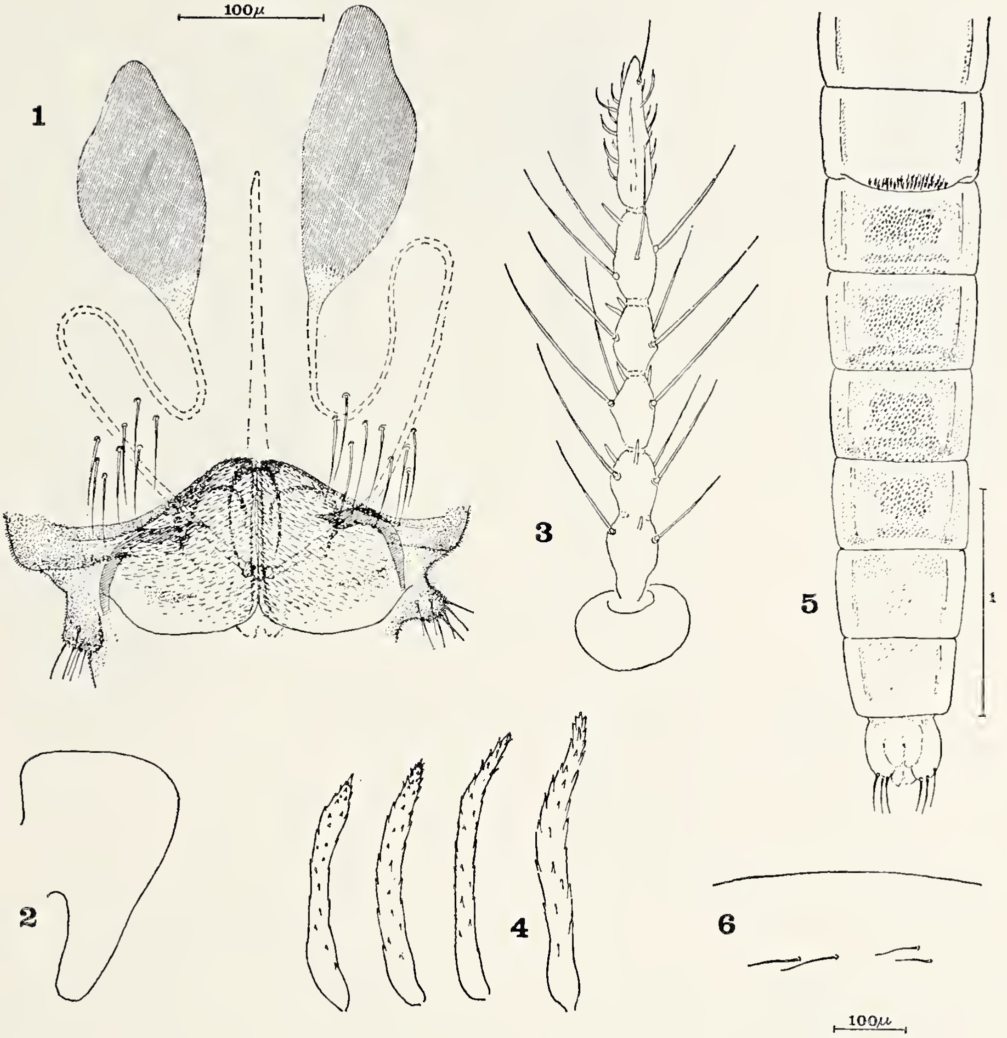


Figure 81. *Cricotopus* (*C.*) *ephippium* (Zett.), adult, pupa. Spermathecae and outer genitalia (1); cercus (2); antenna of ♀ (3); thoracic horn (4); shagreen of abdominal segments of pupa (5); size relationship and arrangement of Dc setae of pupal exuvium (6). Scale of drawings 1=2−4.

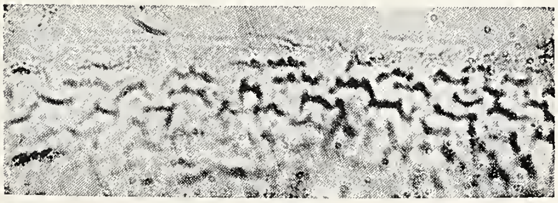


Figure 82. *Cricotopus* (*C.*) *ephippium* (Zett.), pupa. Margin of pronotal suture.

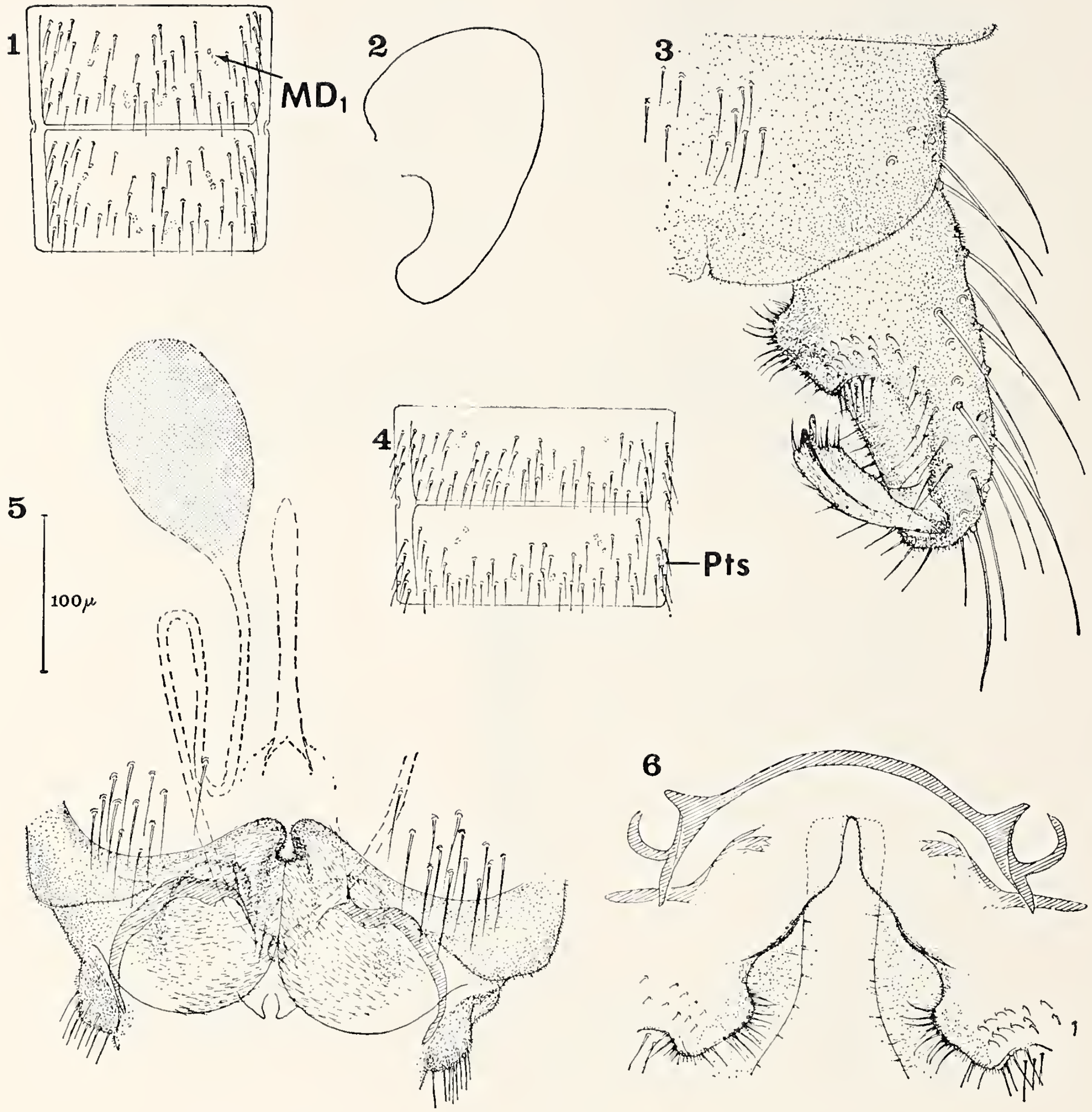


Figure 83. *Cricotopus* (*C.*) *gelidus* (Kieff.), adult. Chaetotaxy scheme for abdominal tergites III and IV of ♂ (1); cercus of ♀ (2); hypopygium of ♂ (3); chaetotaxy scheme for abdominal tergites III and IV (with Pts) of ♀ (4); spermatheca and outer genitalia of ♀ (5); aedeagal lobe and phallapodeme of hypopygium (6). Scale of drawings 2=3, 5, 6.—MD₁ anterolateral muscle marks, Pts paratergital setae.

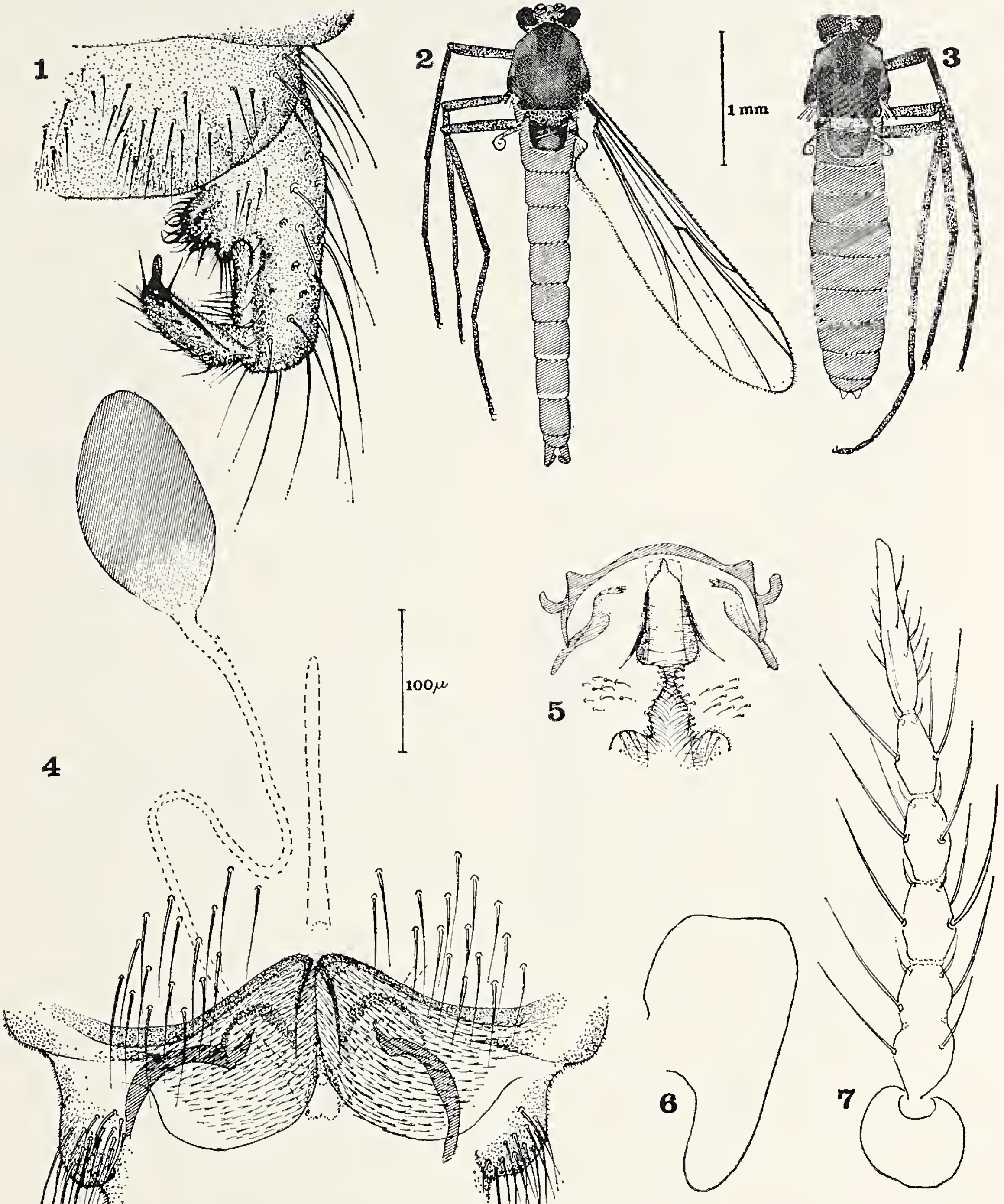


Figure 84. *Cricotopus* (*C.*) *lestralis* (Edw.), adult. Hypopygium of ♂ (1); ♂ (2); ♀ (3); spermatheca and outer genitalia of ♀ (4); aedeagal lobe and phallapodeme of hypopygium (5); cercus of ♀ (6); antenna of ♀ (7). Scale of drawings 1=4–7; 2=3.

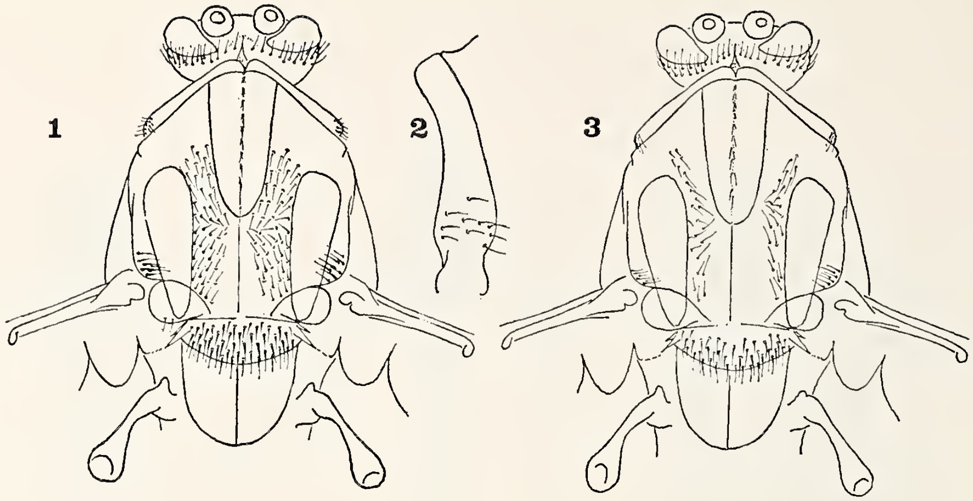


Figure 85. Chaetotaxy scheme for head and thorax, dorsal (1) and antepronotum, lateral (2) of *Cricotopus* (*C.*) *tibialis* (Meig.); chaetotaxy scheme for head and thorax of a population from Canada, "*C.* cfr. *tibialis*" (Meig.), see p. 161 (3).

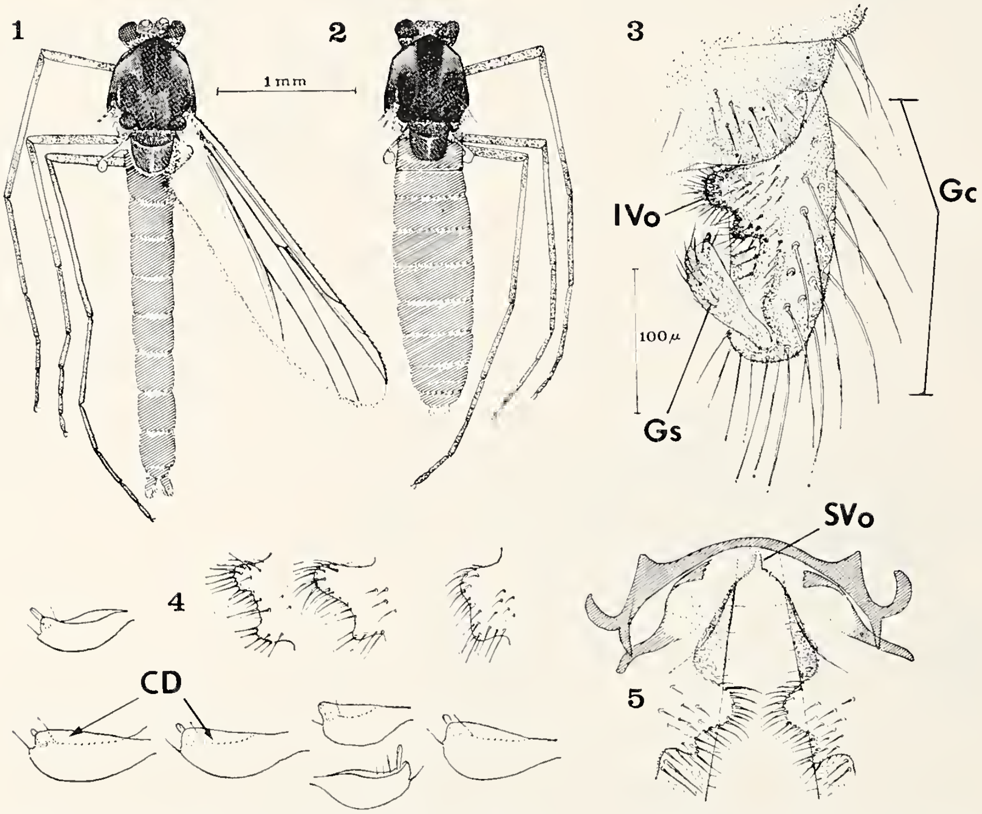


Figure 86. *Cricotopus* (*C.*) *tibialis* (Meig.), adult. ♂ (1); ♀ (2); hypopygium of ♂ (3); variation in inferior volsella and gonostylus (partly produced by preparation) (4); aedeagal lobe and phallapodeme of hypopygium (5).—CD crista dorsalis, Gc gonocoxite, Gs gonostylus, IVo inferior volsella, SVo superior volsella.

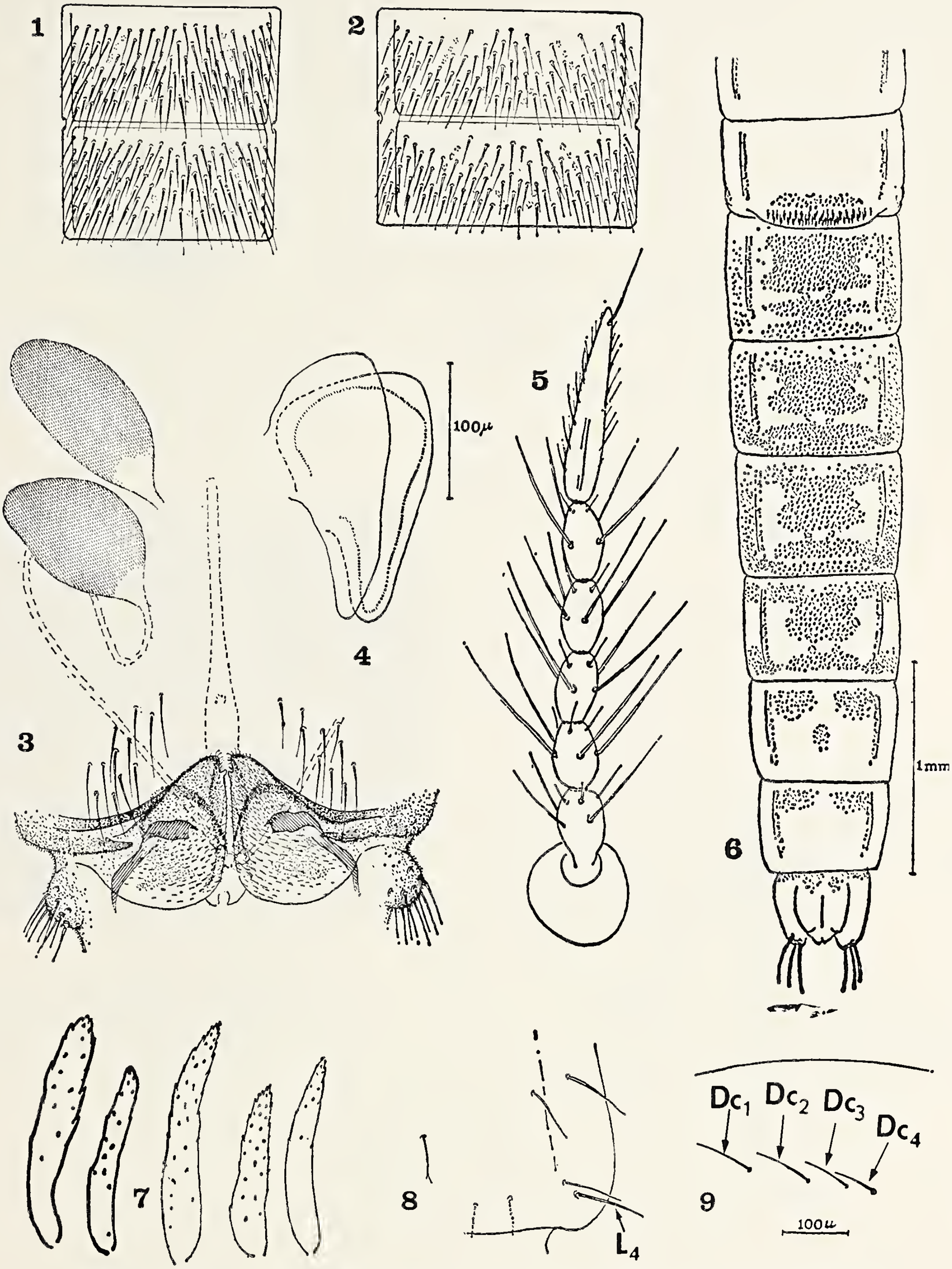


Figure 87. *Cricotopus* (*C.*) *tibialis* (Meig.), adult, pupa. Chaetotaxy scheme for abdominal tergites III and IV of ♂ (1); same (with Pts) of ♀ (2); spermathecae and outer genitalia (3); variation in cerci (4); antenna of ♀ (5); shagreen of abdominal tergites (6); variation in thoracic horn (left from Spitzbergen, right from Germany) (7); anal angle of abdominal segment VIII of pupa (8); size relationship and arrangement of Dc setae of pupa. (9). Scale of drawings 3=4–7; 8=9.

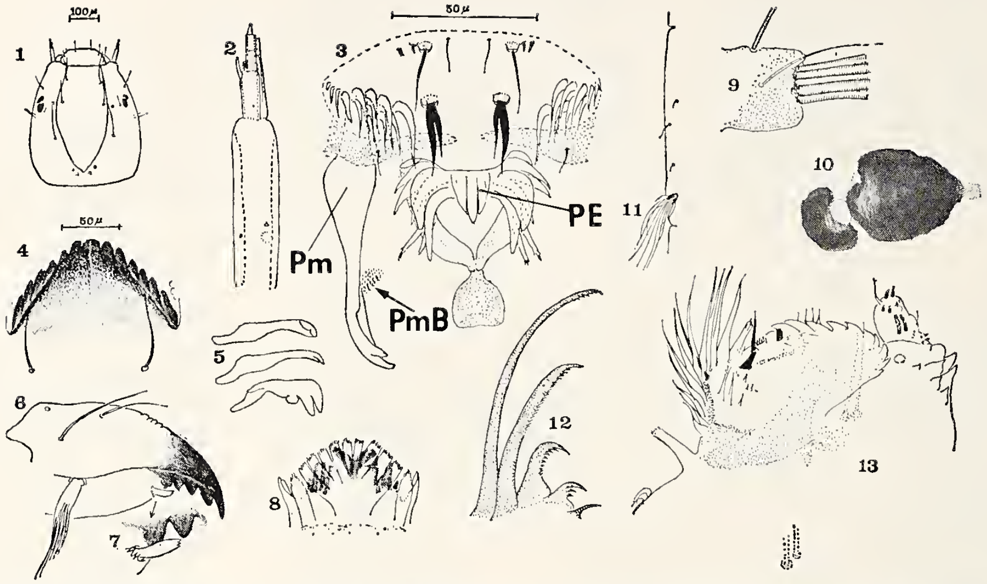


Figure 88. *Cricotopus* (*C.*) *tibialis* (Meig.), larva. Head, dorsal (1); antenna (2); palatal surface of labrum and premandible (with marks of premandibular brushes) (3); mentum (4); premandible (5); mandible (6); SSd of mandible (7); prementum (8); procercus (9); eyespots (10); L setae of abdominal segment III (11); claws of anterior parapods (12); maxilla (13). Scale of drawings 1=11; 2=3, 7−10, 12−13; 4=5−6.—PE pecten epipharyngis, Pm premandible, PmB premandibular brush.

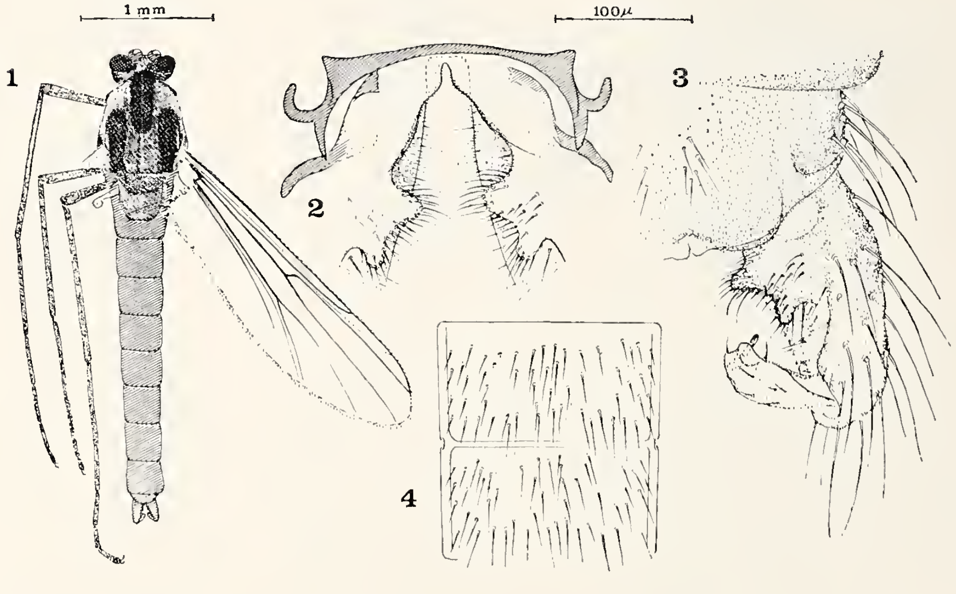


Figure 89. "*Cricotopus* cfr. *tibialis* (Meig.)", adult. ♂ (1); aedeagal lobe and phallapodeme of hypopygium (2); hypopygium (3); chaetotaxy scheme for abdominal tergites III and IV of ♂ (4).

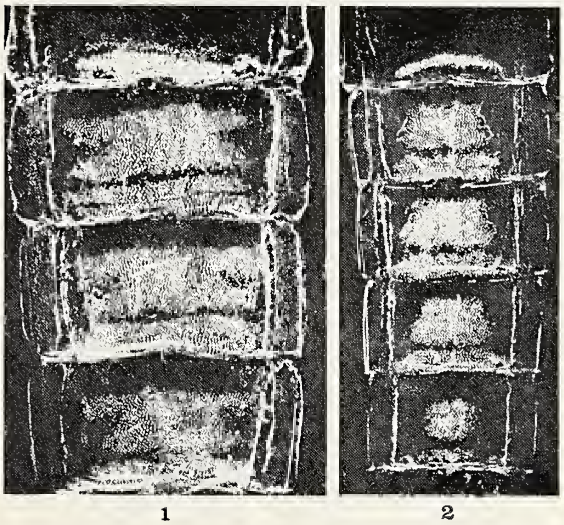


Figure 90. Shagreen of abdominal segments II–V of the pupal exuviae of *Cricotopus* (*C.*) *tibialis* (Meig.) (1) and of segments II–VI of *C.* (*C.*) *polaris* Kieff. (2). (Dark field photography).

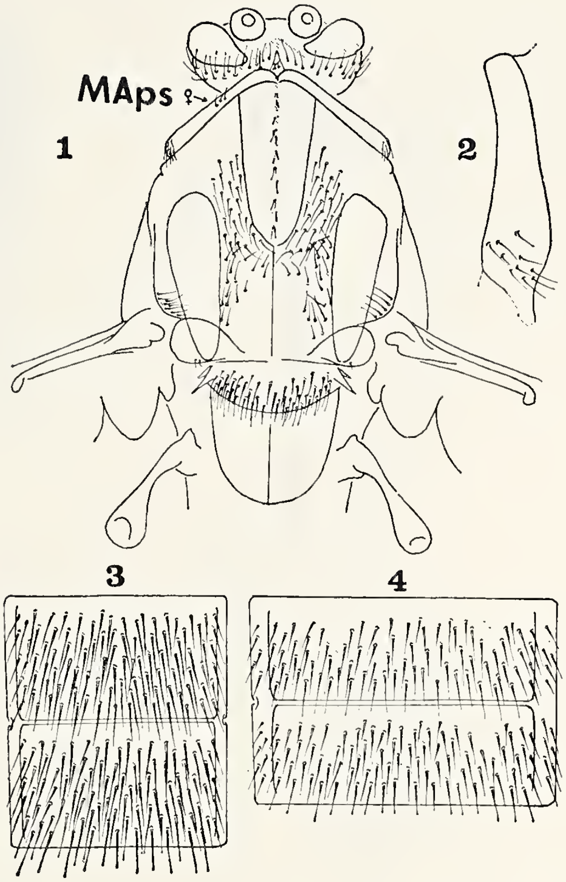


Figure 91. *Cricotopus* (*C.*) *polaris* Kieff. (Sompiojarvi), adult. Chaetotaxy scheme for head and thorax, dorsal (1); antepronotum of ♂, lateral (2); setation scheme for abdominal tergites III and IV of ♂ (3); same of ♀ (with Pts) (4).—MAps median setae of antepronotum.

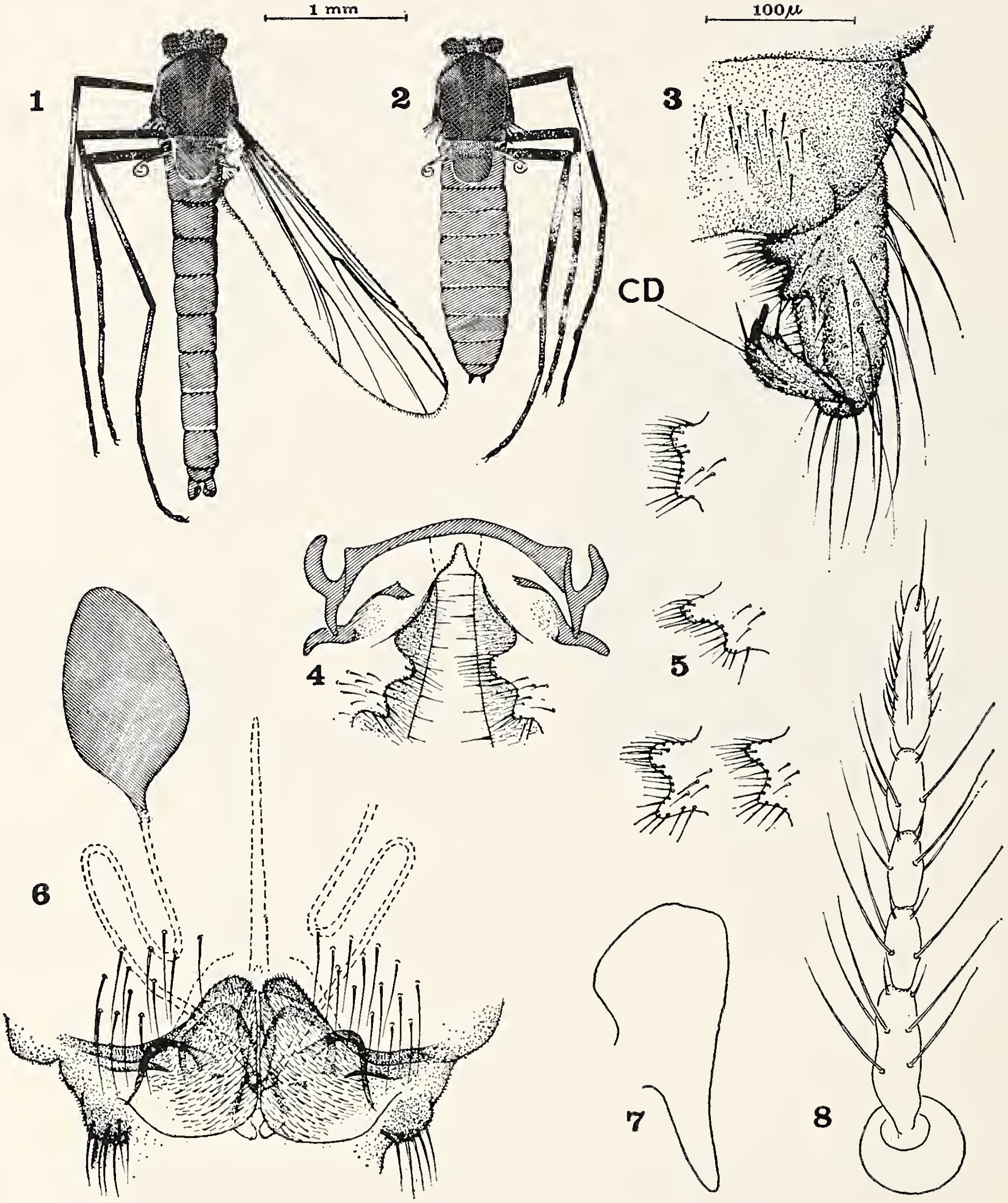
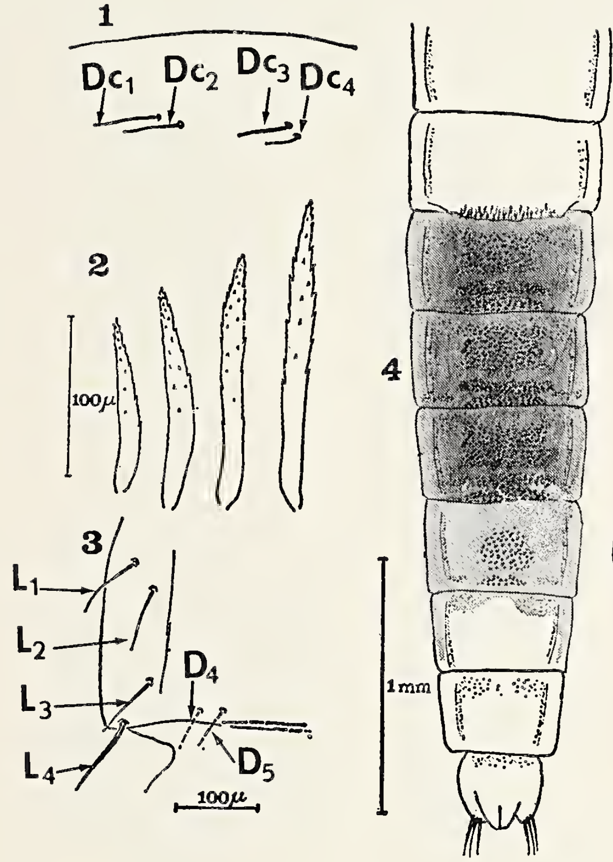


Figure 92. *Cricotopus* (*C.*) *polaris* Kieff., (Sompiojarvi), adult. ♂ (1); ♀ (2); hypopygium of ♂ (3); aedeagal lobe and phallapodeme of hypopygium (4); variation in inferior volsella (partly caused through preparation) (5); spermatheca and outer genitalia (6); cercus of ♀ (7); antenna of ♀ (8). Scale of drawings 1=2; 3=4−8.—CD crista dorsalis



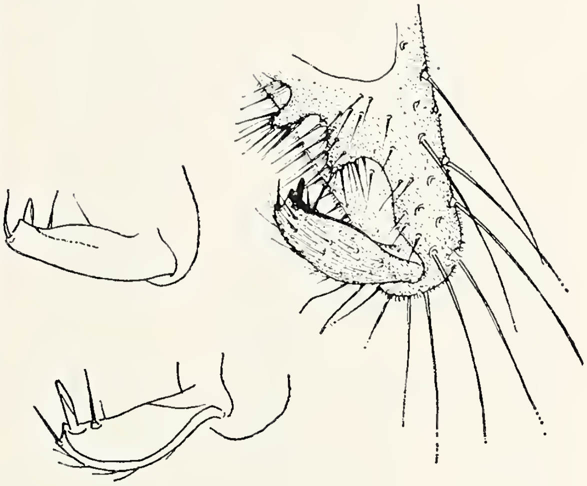


Figure 93. *Cricotopus* (*C.*) *polaris* Kieff. (Sompiojarvi), pupa. Size relationship and arrangement of Dc setae (1); variation of thoracic horn (2); anal angle of abdominal segment VIII (Scale = drawing 1) (3); shagreen and pigmentation of abdominal segments (4).

Figure 94. *Cricotopus* (*C.*) *polaris* Kieff., adult from Utsjoki, Finnish-Lappland. Gonocoxite, apical, and variation of gonostylus from a different view.

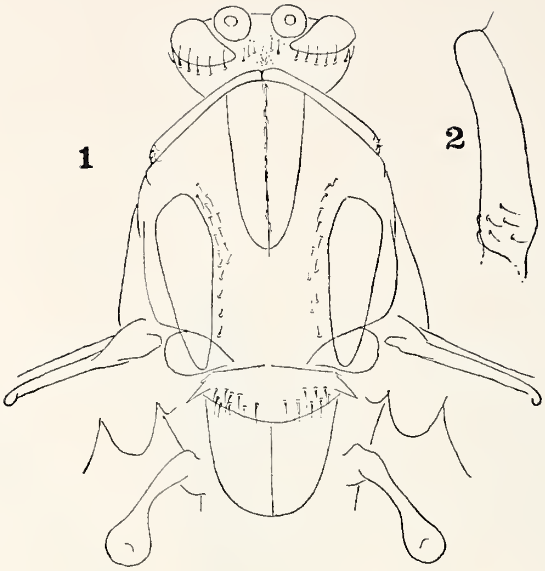


Figure 95. *Cricotopus* (*C.*) *fuscus* (Kieff.), chaetotaxy scheme for head and thorax of adult, dorsal (1); *C.* (*C.*) *pirifer* Hirv., antepronotum of adult, lateral (2).

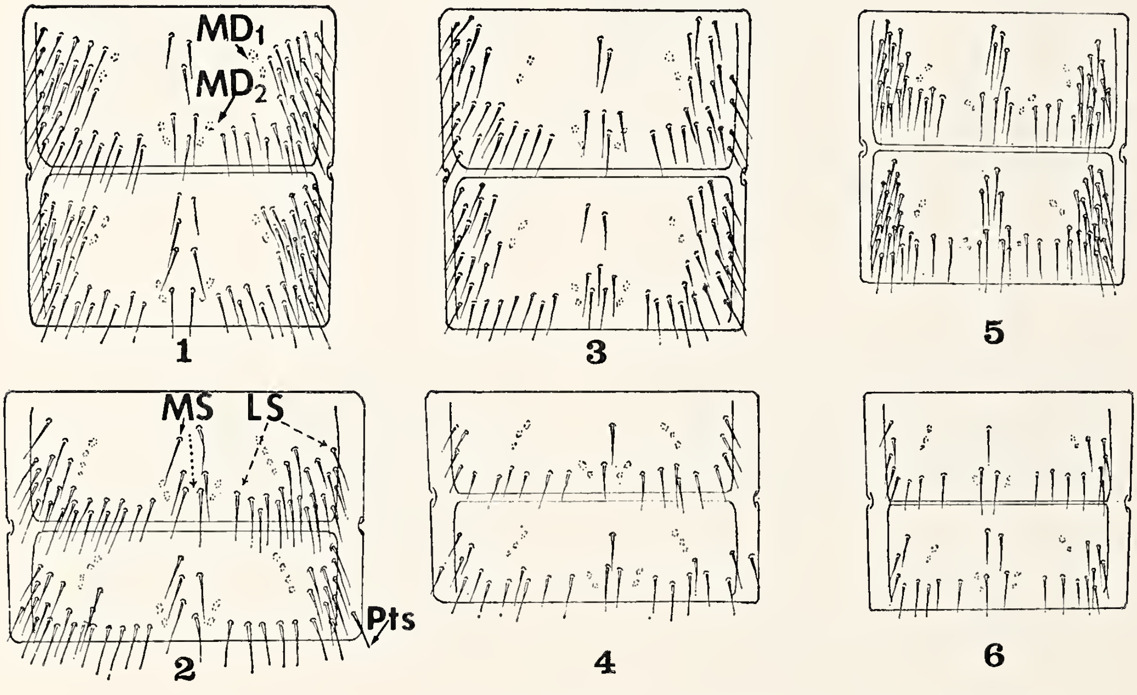


Figure 96. Chaetotaxy scheme for abdominal segments III and IV, dorsal, of the adults of the *fuscus*-group. *Cricotopus* (*C.*) *fuscus* (Kieff.) ♂ (1); same; ♀ (2); *C.* (*C.*) *algarum* (Kieff.) ♂ (3); same, ♀ (4); *C.* (*C.*) *pirifer* ♂ (5); same, ♀ (6). MD$_{1-2}$ muscle marks, LS lateral setae, MS median setae, Pts paratergital setae.

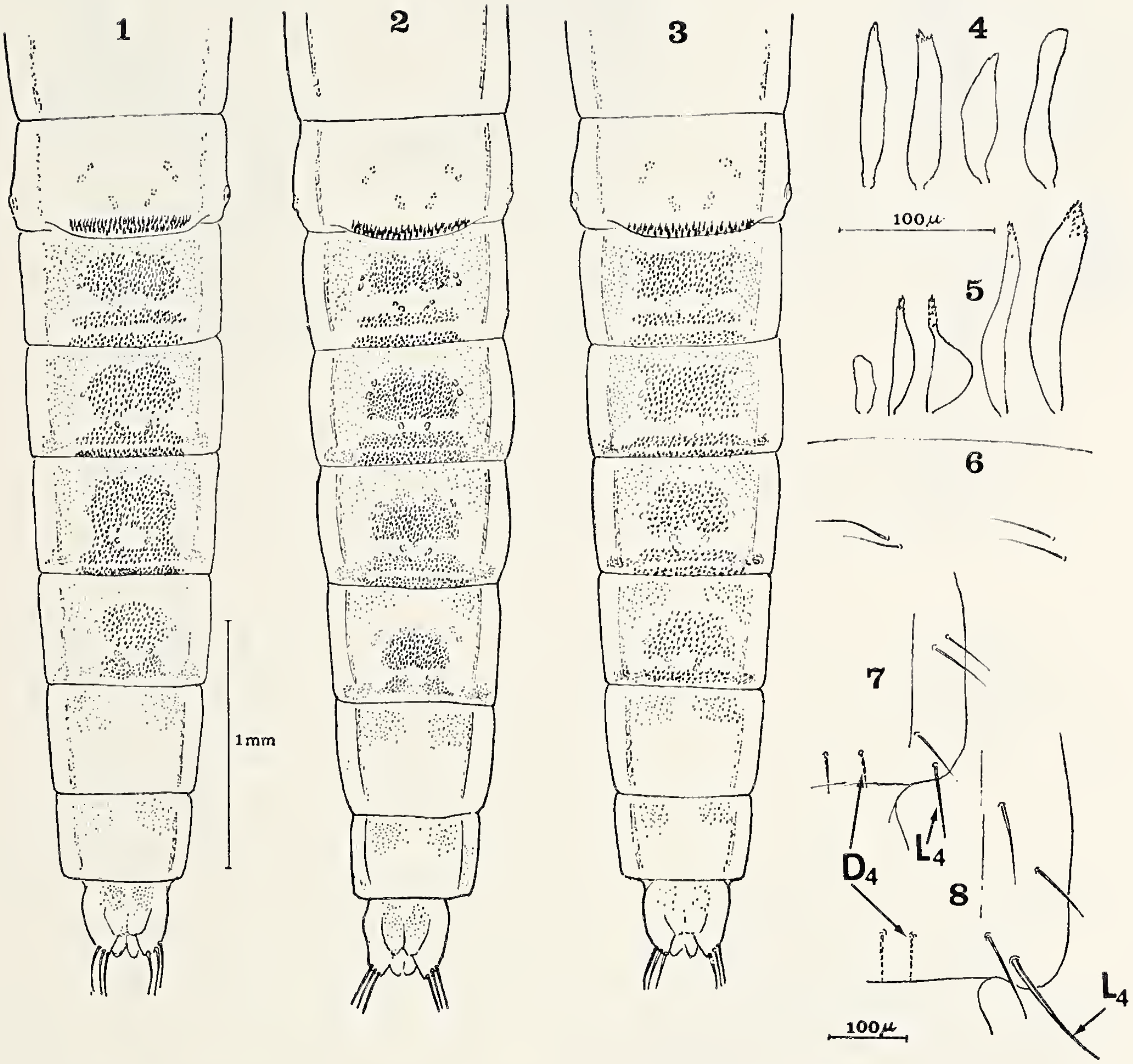


Figure 97. Shagreen of abdominal tergites of pupal exuviae of *Cricotopus* (*C.*) *pirifer* Hirv. (1); *C.* (*C.*) *fuscus* (Kieff.) (2); *C.* (*C.*) *algarum* (Kieff.) (3); variation in thoracic horn of pupa of *pirifer* (4);and *fuscus* (5); size relationship and arrangement of Dc_{1-4} of pupa of *pirifer* (6); setae on anal angle of segment VIII of *pirifer* (7); and *fuscus* (8). Scale of drawings 1=2−3; 4=5; 6=7−8.

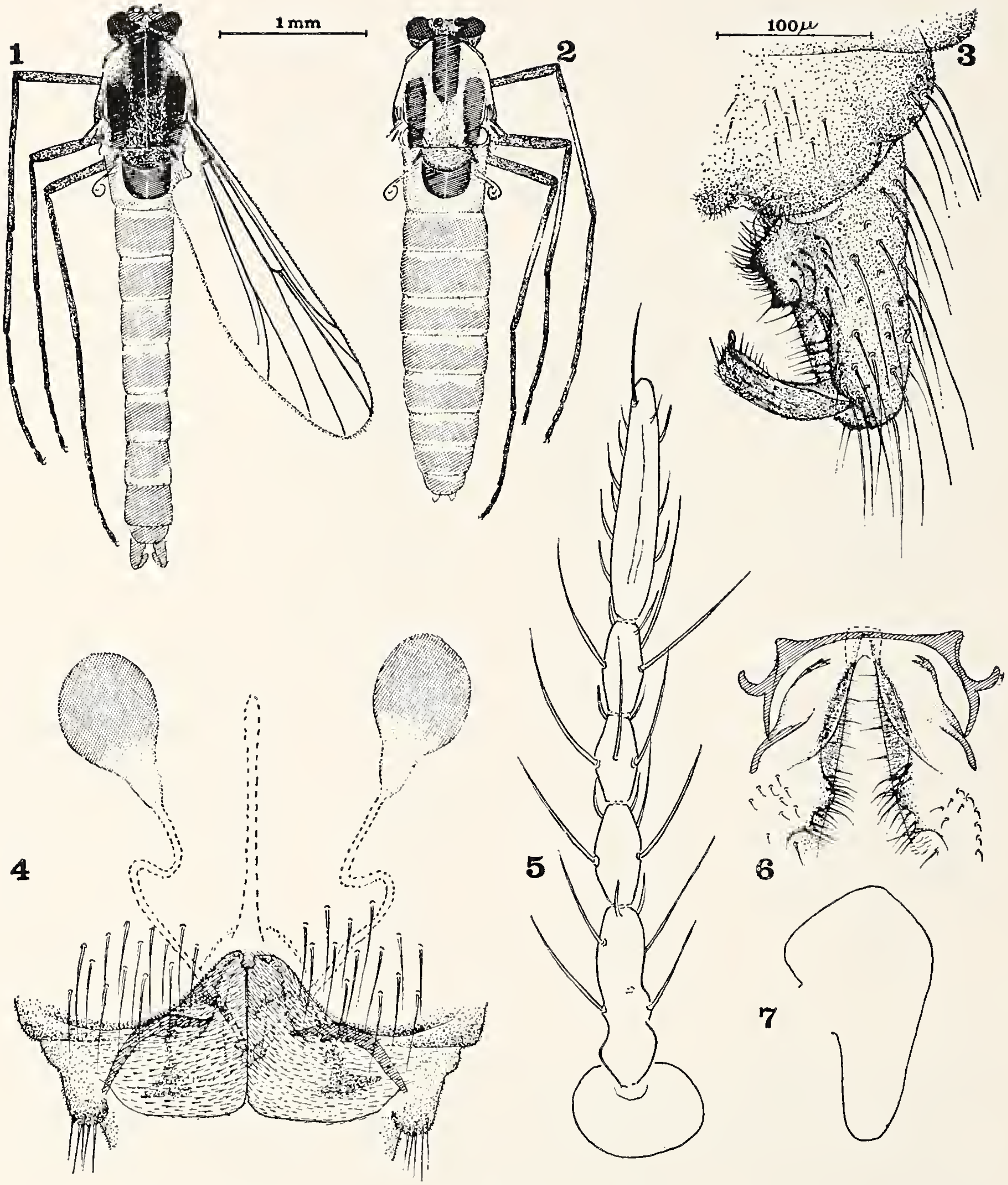


Figure 98. *Cricotopus* (*C.*) *fuscus* (Kieff.), adult. ♂ (1); ♀ (2); hypopygium of ♂ (3); spermathecae and outer genitalia (4); antenna of ♀ (5); aedeagal lobe and phallapodeme of hypopygium of ♂ (6); cercus of ♀ (7). Scale of drawings 1=2, 3=4−7.

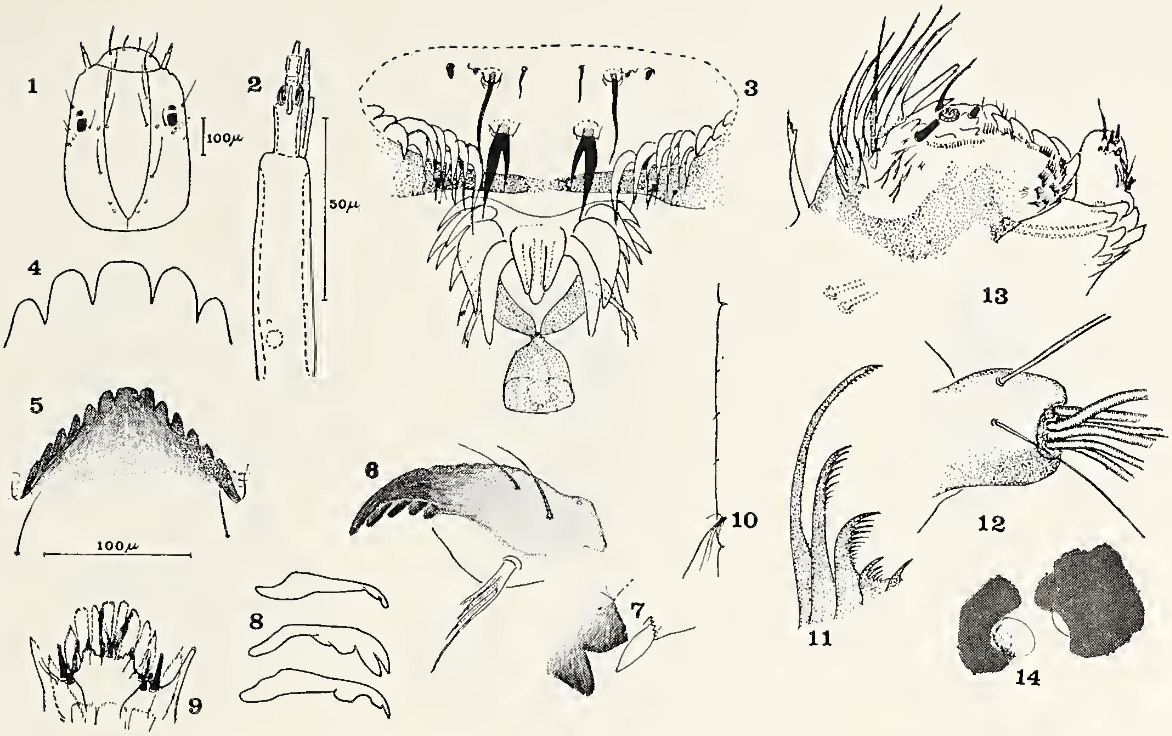


Figure 99. *Cricotopus* (*C.*) *fuscus* (Kieff.), larva. Head, dorsal (1); antenna (2); palatal surface of labrum (3); median tooth and first two lateral teeth of mentum (4); mentum (5); mandible (6); SSd of mandible (7); premandible (8); prementum (9); L setae of abdominal segment IV (10); claws of anterior parapods (11); procercus (12); maxilla (13); eyespots (14). Scale of drawings 1=10; 2=3–4, 7, 9, 11–14; 5=6, 8.

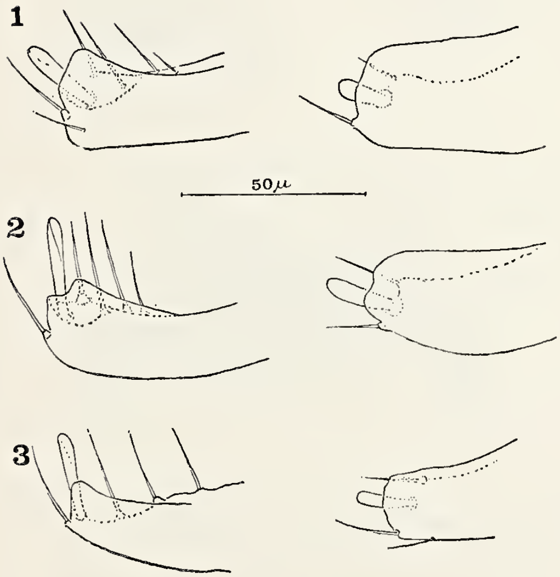


Figure 100. Distal end of gonostylus. *Cricotopus* (*C.*) *fuscus* (Kieff.) (1); *C.* (*C.*) *algarum* (Kieff.) (2); *C.* (*C.*) *pirifer* Hirv. (3).

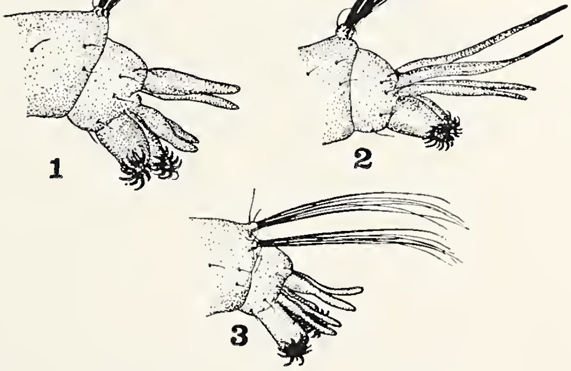


Figure 101. Posterior end of larvae. *Cricotopus* (*C.*) *fuscus* (Kieff.) (1); *C.* (*C.*) *algarum* (Kieff.) (2); *C.* (*C.*) *pirifer* Hirv. (3).

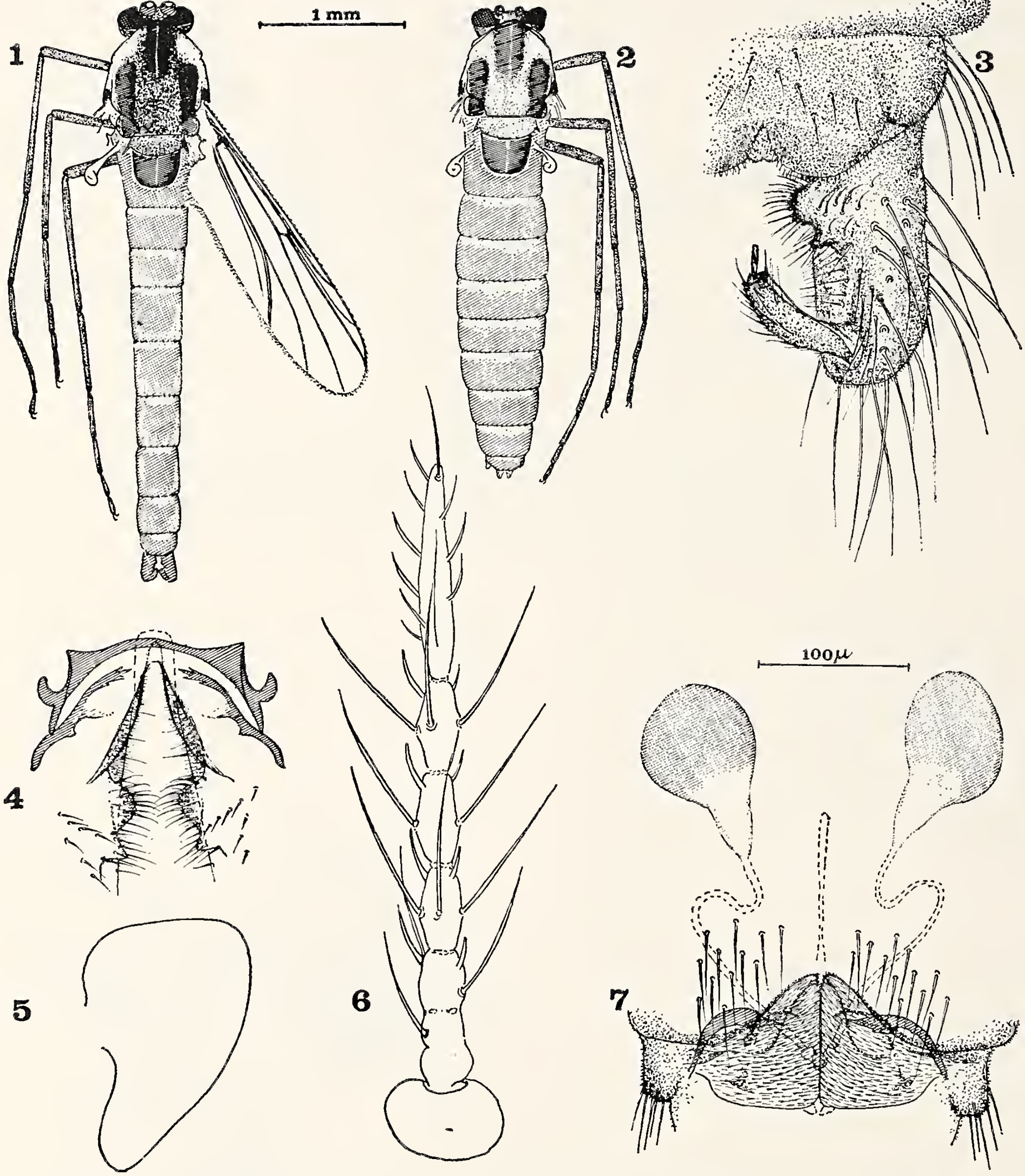


Figure 102. *Cricotopus* (*C.*) *algarum* (Kieff.), adult. ♂ (1); ♀ (2); hypopygium of ♂ (3); aedeagal lobe and phallapodeme of hypopygium (4); cercus (5); antenna (6); spermathecae and outer genitalia of ♀ (7). Scale of drawings 1=2; 3=4−7.

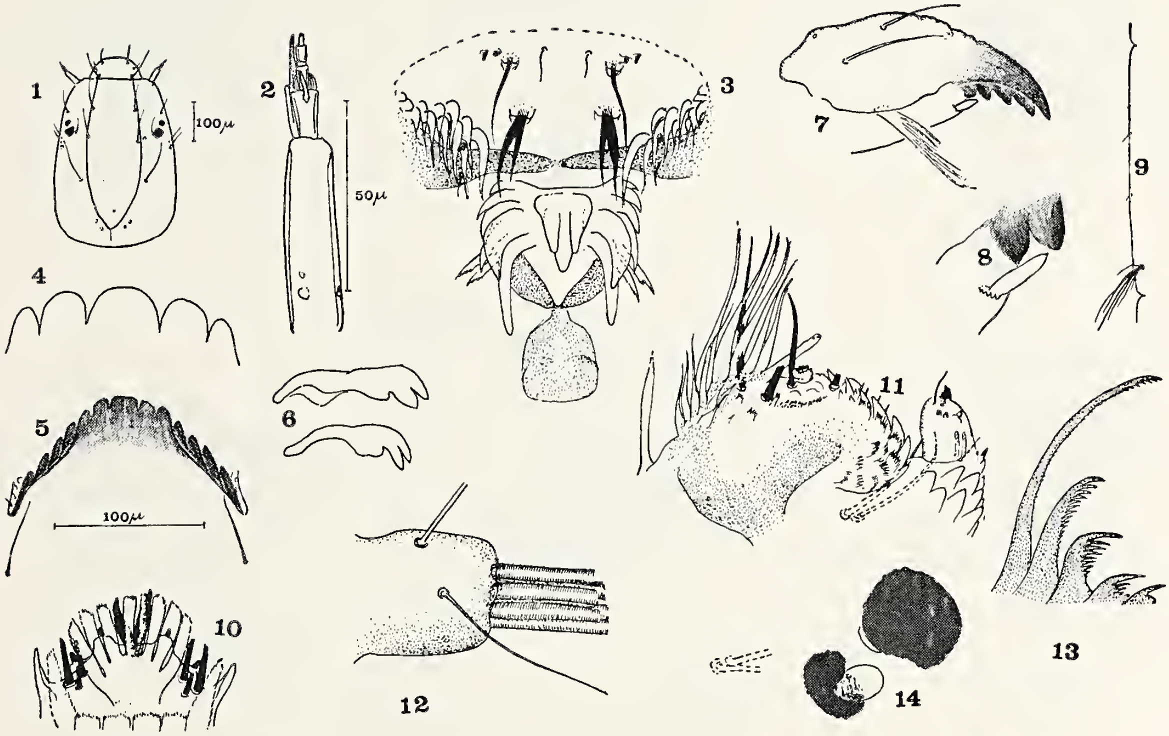


Figure 103. *Cricotopus* (*C.*) *algarum* (Kieff.), larva. Head, dorsal (1); antenna (2); palatal surface of labrum (3); median tooth and first two lateral teeth of mentum (4); mentum (5); premandible (6); mandible (7); SSd of mandible (8); L setae of abdominal segment IV (9); prementum (10); maxilla (11); procercus (12); claws of anterior parapods (13); eyespots (14). Scale of drawings 1=9; 2=3–4, 8, 10–14; 5=6–7.

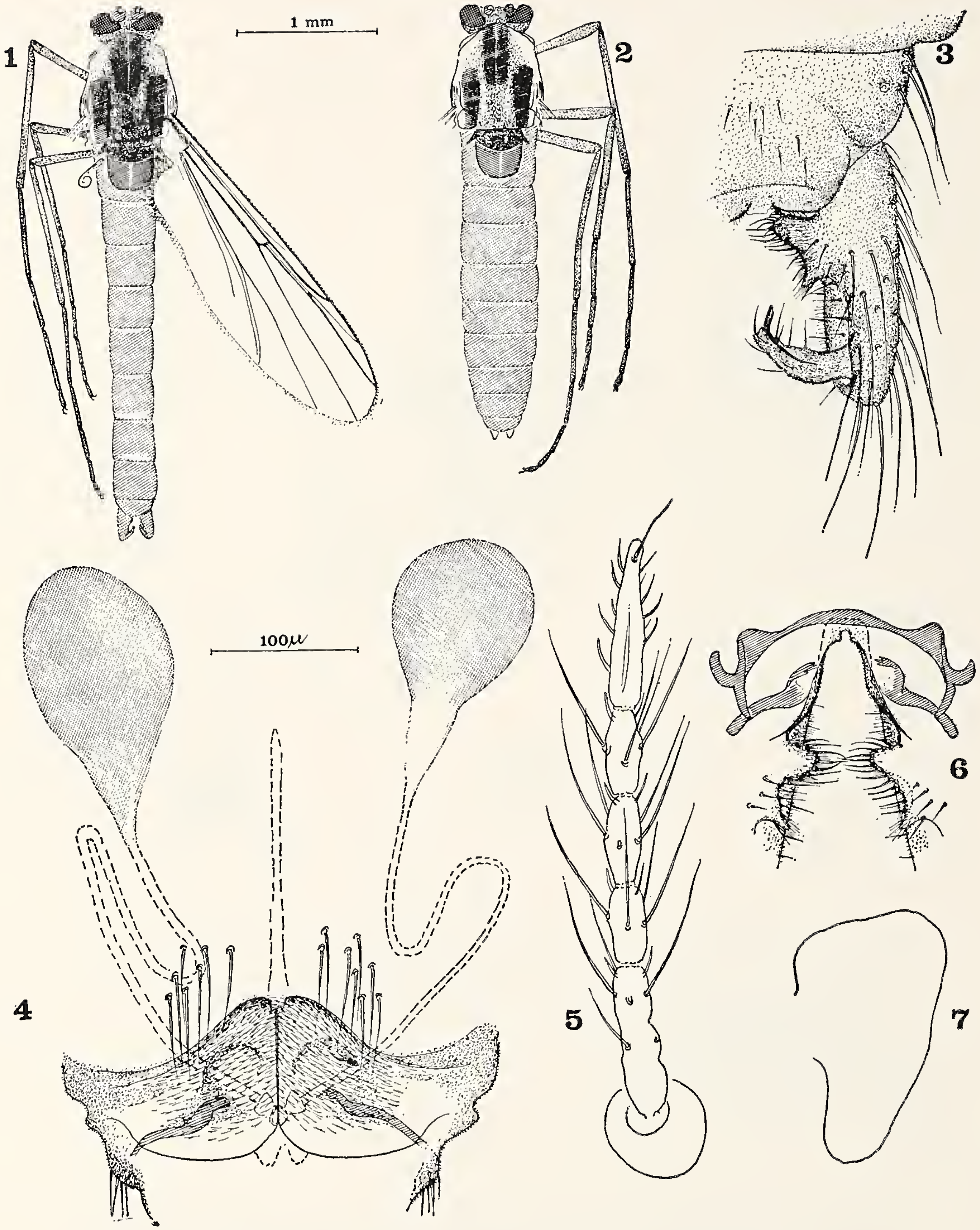


Figure 104. *Cricotopus* (*C.*) *pirifer* Hirv., adult. ♂ (1); ♀ (2); hypopygium of ♂ (3); spermathecae and outer genitalia of ♀ (4); antenna of ♀ (5); aedeagal lobe and phallapodeme of hypopygium of ♂ (6); cercus of ♀ (7). Scale of drawings 1=2; 3=4−7.

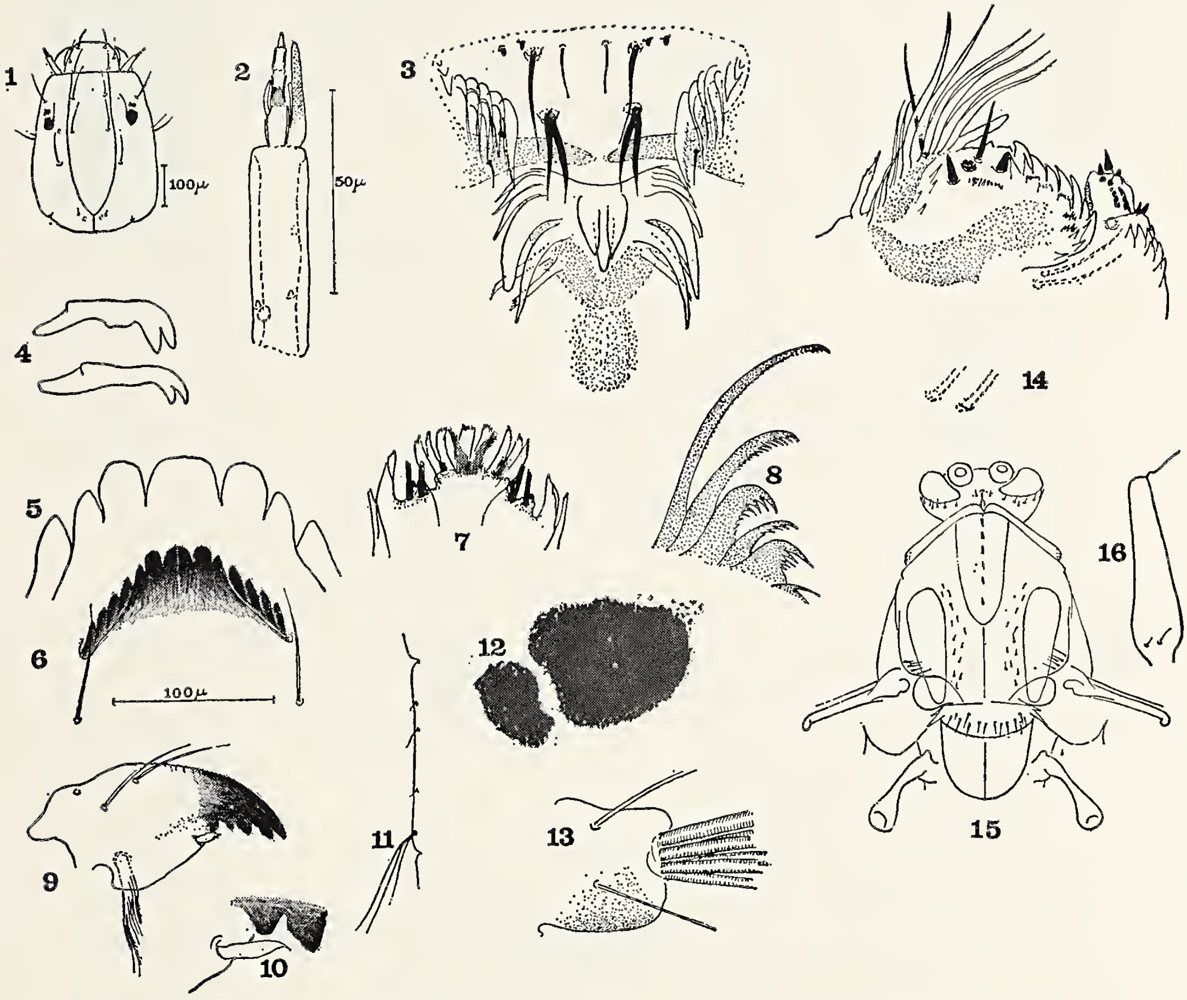


Figure 105. *Cricotopus* (*C.*) *pirifer* Hirv., larva. Head, dorsal (1); antenna (2); palatal surface of labrum (3); premandible (4); median tooth and first three lateral teeth of mentum (5); mentum (6); prementum (7); claws of anterior parapods (8); mandible (9); SSd of mandible (10); L setae of abdominal segment IV (11); eyespots (12); procercus (13); maxilla (14). Chaetotaxy of head and thorax, dorsal (15) and antepronotum, lateral (16) of adult of *Cricotopus* (*C.*) *magus* Hirv. Scale of drawings 1=11; 2=3, 5, 7, 8, 10, 12–14; 4=6, 9; 15 and 16 schematic freehand sketch.

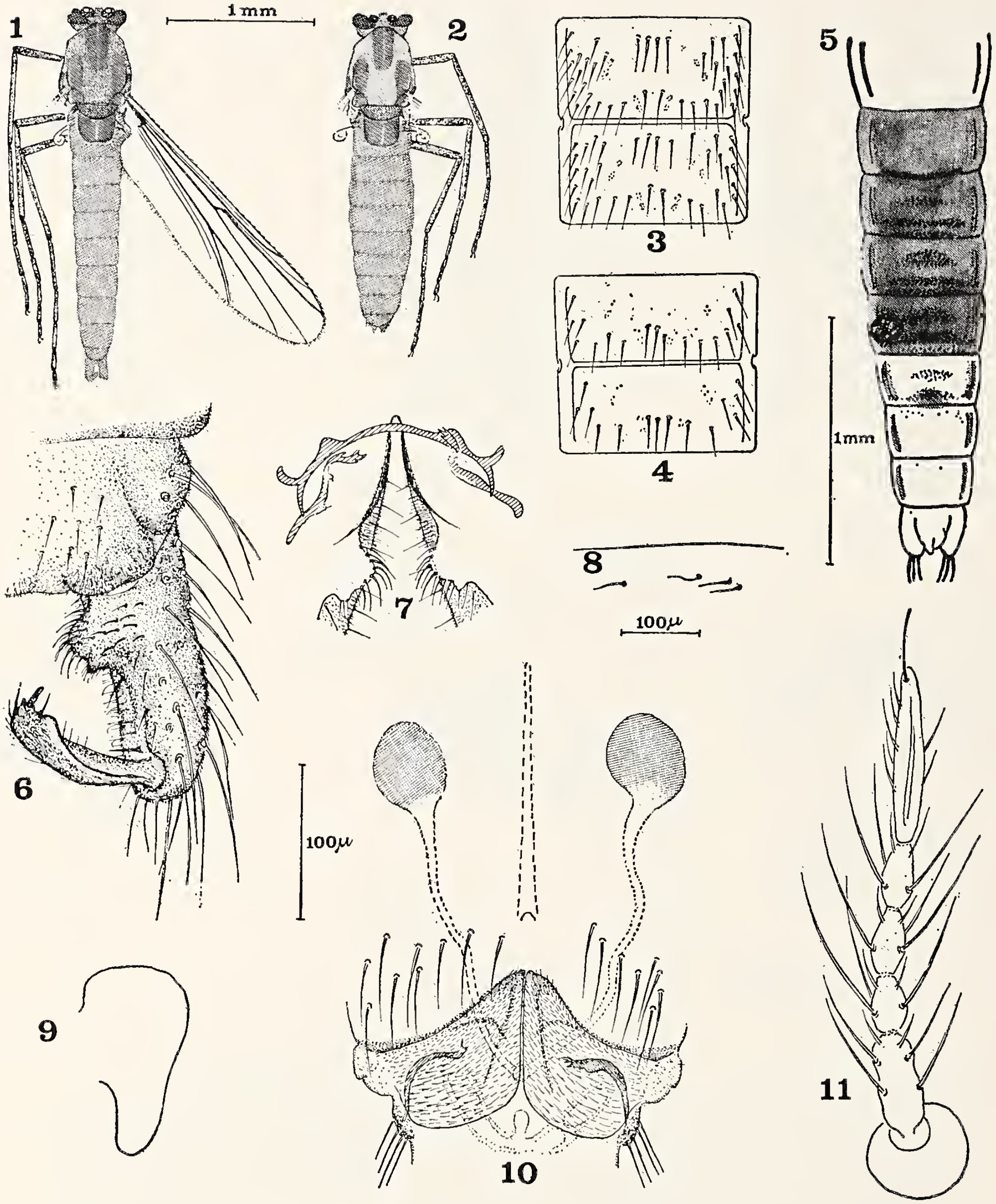


Figure 106. *Cricotopus* (*C.*) *magus* Hirv., adult and pupa. ♂ (1); ♀ (2); chaetotaxy scheme for abdominal tergites III and IV of ♂ (3) and ♀ (4); abdominal segments of pupal exuvium (5); hypopygium of ♂ (6); aedeagal lobe and phallapodeme of hypopygium (7); size relationship and arrangement of Dc setae of pupa (8); cercus (9); spermathecae and outer genitalia (10); antenna of ♀ (11). Scale of drawings 1=2; 6=7, 9−11.

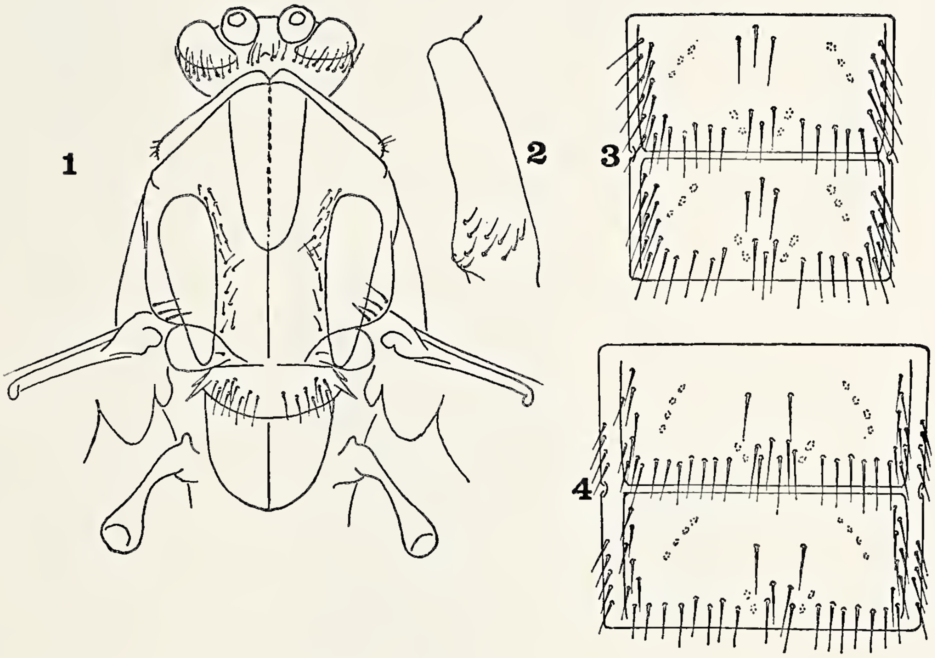


Figure 107. *Cricotopus* (*C.*) *septentrionalis* Hirv., adult. Chaetotaxy scheme for head and thorax, dorsal (1); antepronotum of ♂, lateral (2); chaetotaxy scheme for abdominal tergites III and IV of ♂ (3); same (with Pts) of ♀ (4).

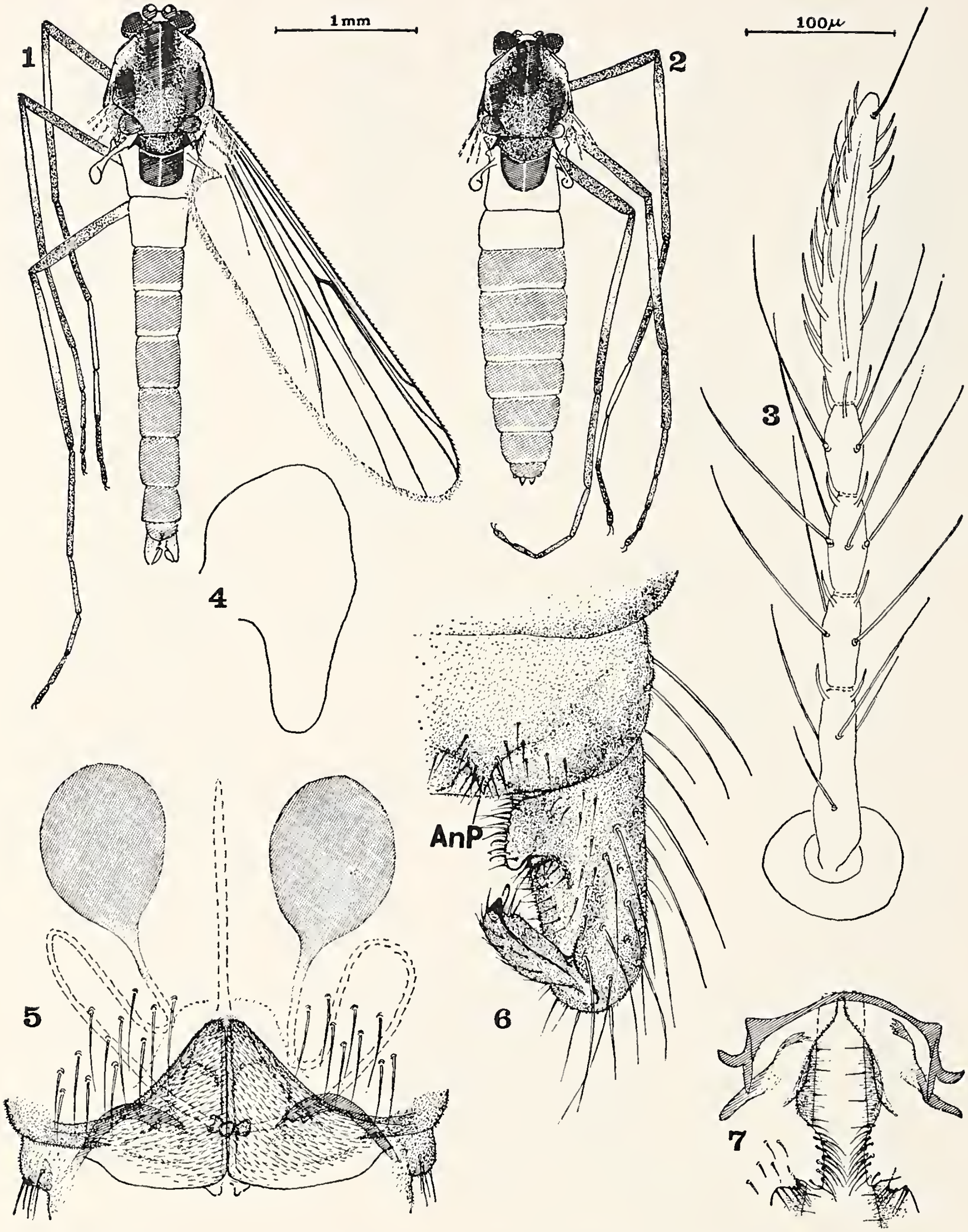


Figure 108. *Cricotopus* (*C.*) *septentrionalis* Hirv., adult. ♂ (1); ♀ (2); antenna (3); cercus (4); spermathecae and outer genitalia of ♀ (5); hypopygium of ♂ (6); aedeagal lobe and phallapodeme of hypopygium (7). Scale of drawings 1=2; 3=4–7.—AnP anal point.

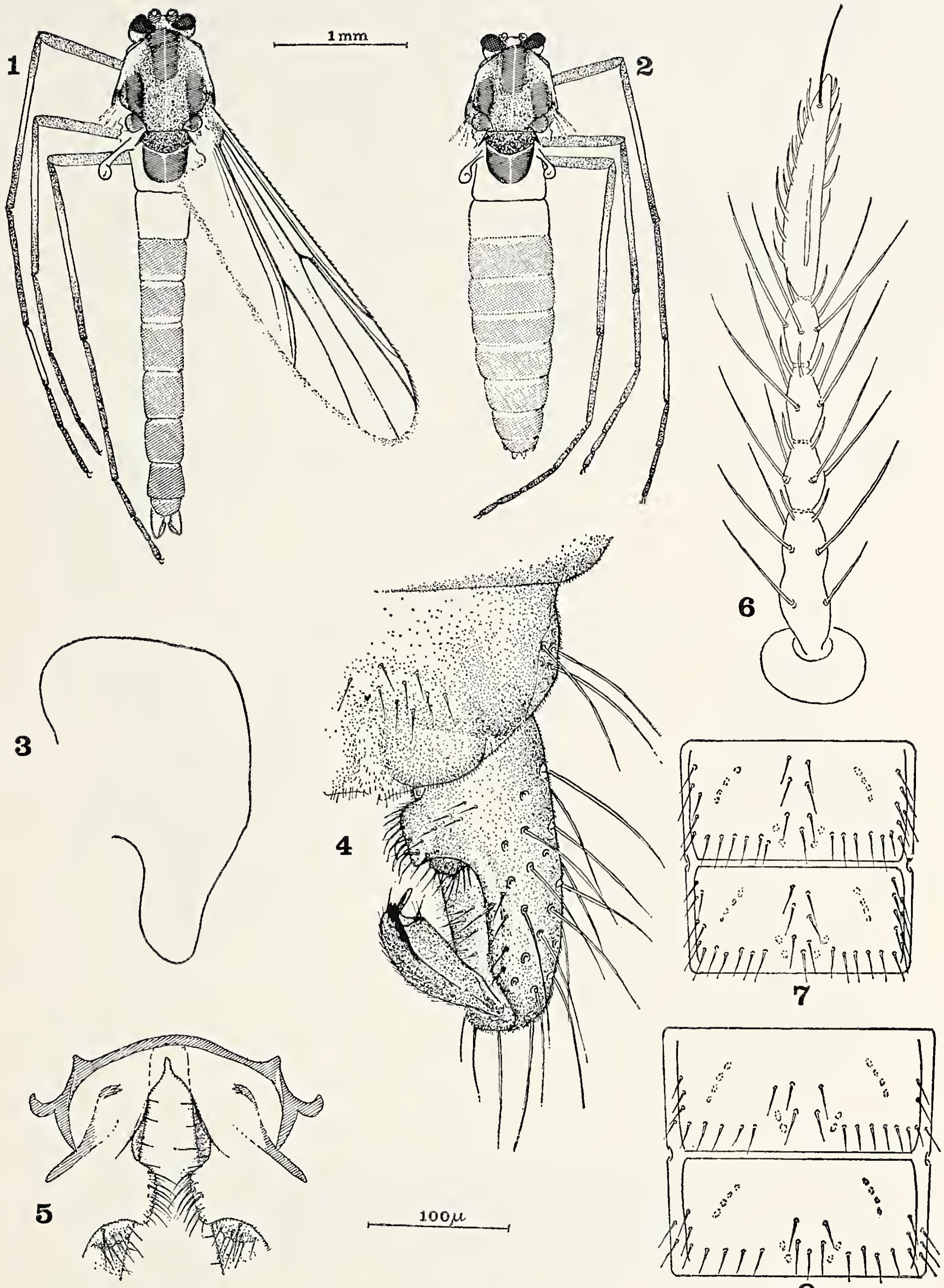


Figure 109. *Cricotopus* (*C.*) *pulchripes* Verr., adult. ♂ (1); ♀ (2); cercus of ♀ (3); hypopygium of ♂ (4); aedeagal lobe and phallapodeme of hypopygium (5); antenna of ♀ (6); chaetotaxy scheme for abdominal tergites III and IV of ♂ (7); same (with Pts) of ♀ (8). Scale of drawings 1=2; 3=4–6; 7 and 8 are freehand sketches.

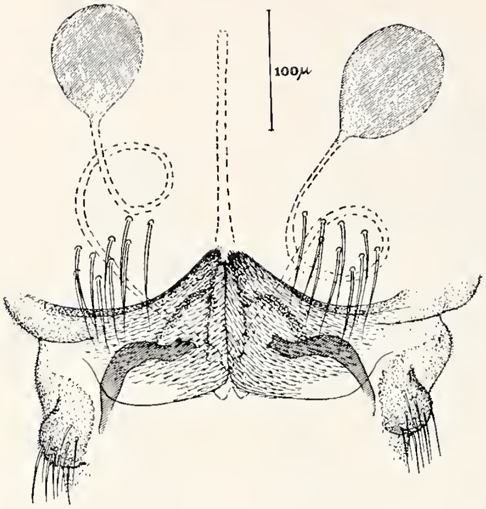


Figure 110. *Cricotopus* (*C.*) *pulchripes* Verr. Spermathecae and outer genitalia of ♀.

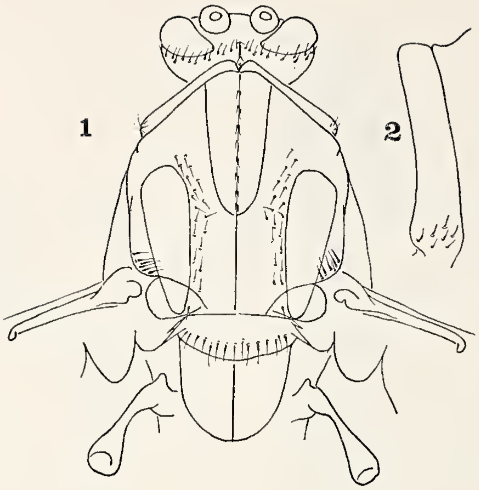


Figure 111. *Cricotopus* (*C.*) *tremulus* (L.), adult. Chaetotaxy scheme for head and thorax, dorsal (1); antepronotum, lateral (2).

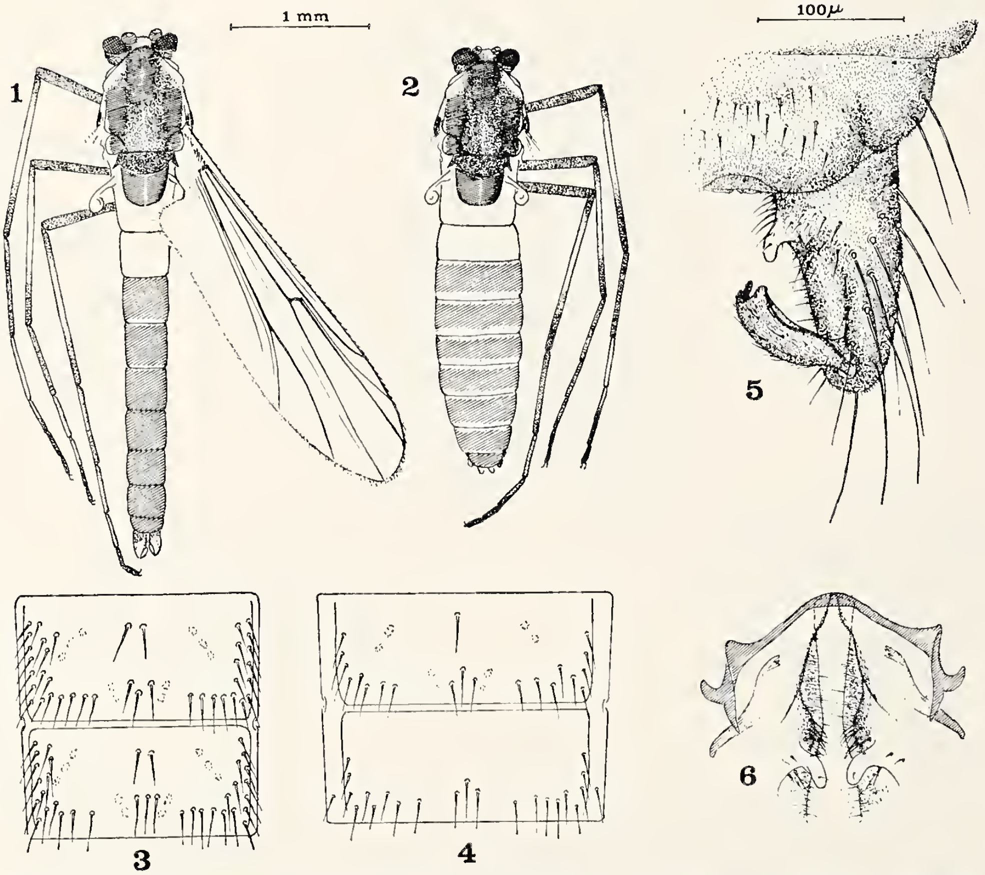


Figure 112. *Cricotopus* (*C.*) *tremulus* (L.), adult. ♂ (1); ♀ (2); chaetotaxy scheme for abdominal tergites III and IV of ♂ (3); same (with Pts) of ♀ (4); hypopygium of ♂ (5); aedeagal lobe and phallapodeme of hypopygium (6). Scale of drawings 1=2; 5=6.

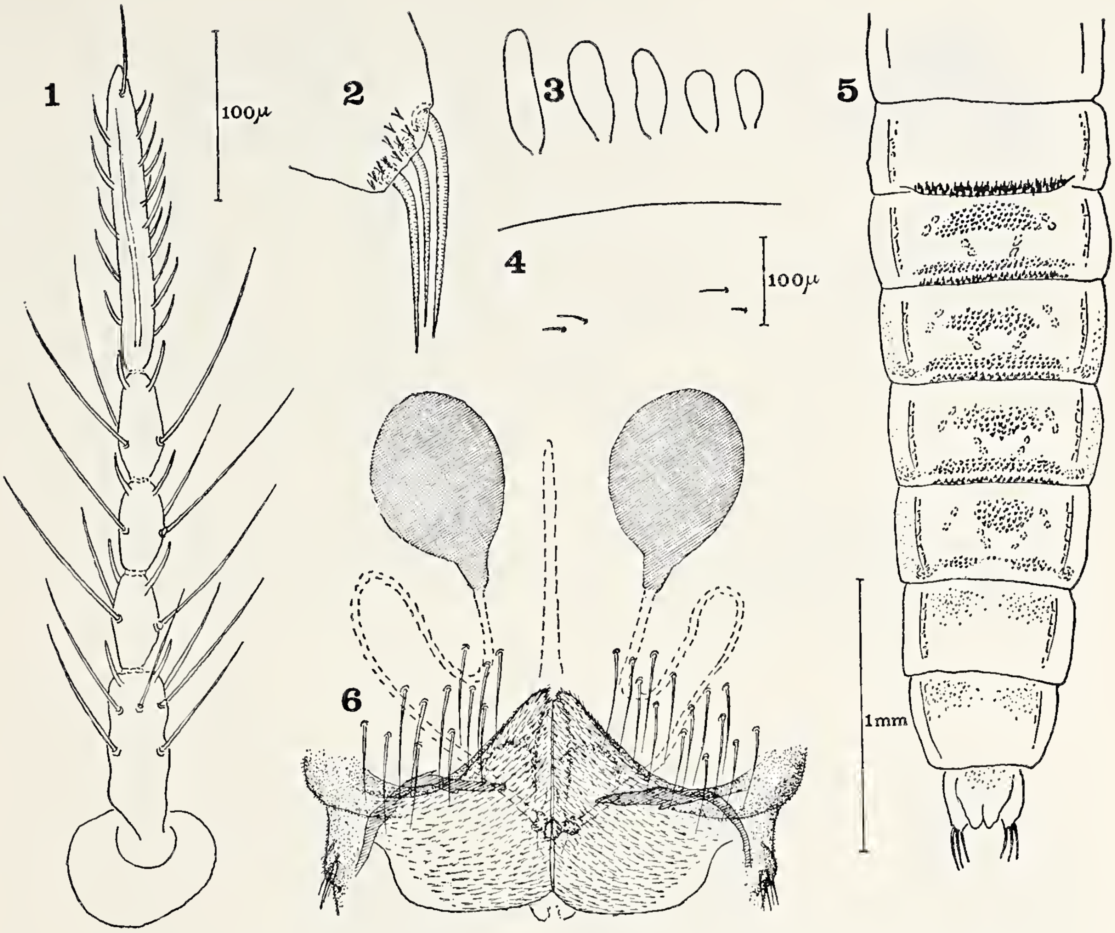


Figure 113. *Cricotopus* (*C.*) *tremulus* (L.), adult, pupa. Antenna of ♀ (1); distal end of paratergite of segment IX of a pupa from the Fulda, Germany (anal macrosetae and possibly rudiments of fringe of anal lobe) (2); thoracic horn (3); size relationship and arrangement of Dc setae of pupa (4); shagreen of abdominal segments of pupa (5); spermathecae and outer genitalia of ♀ (6).

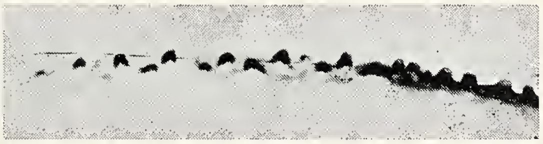


Figure 114. *Cricotopus* (*C.*) *tremulus* (L.). Margin of pronotal suture of pupal exuvium.

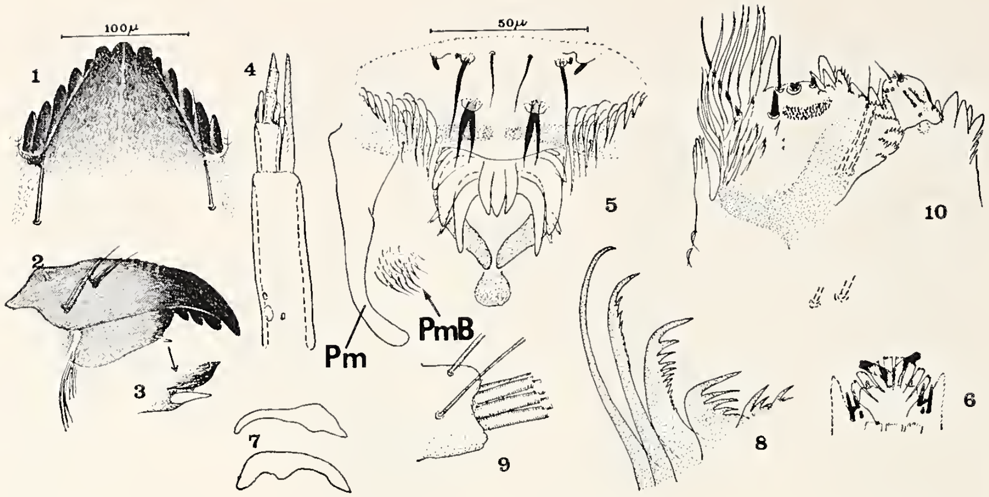


Figure 115. *Cricotopus* (*C.*) *tremulus* (L.), larva. Mentum (1); mandible (2); SSd of mandible (3); antenna (4); palatal surface of labrum and premandible (with premandibular brush) (5); prementum (6); premandible (7); claws of anterior parapods (8); procercus (9); maxilla (10). Scale of drawings 1=2, 7; 3=4–6, 8–10.—Pm premandible, PmB premandibular brush.

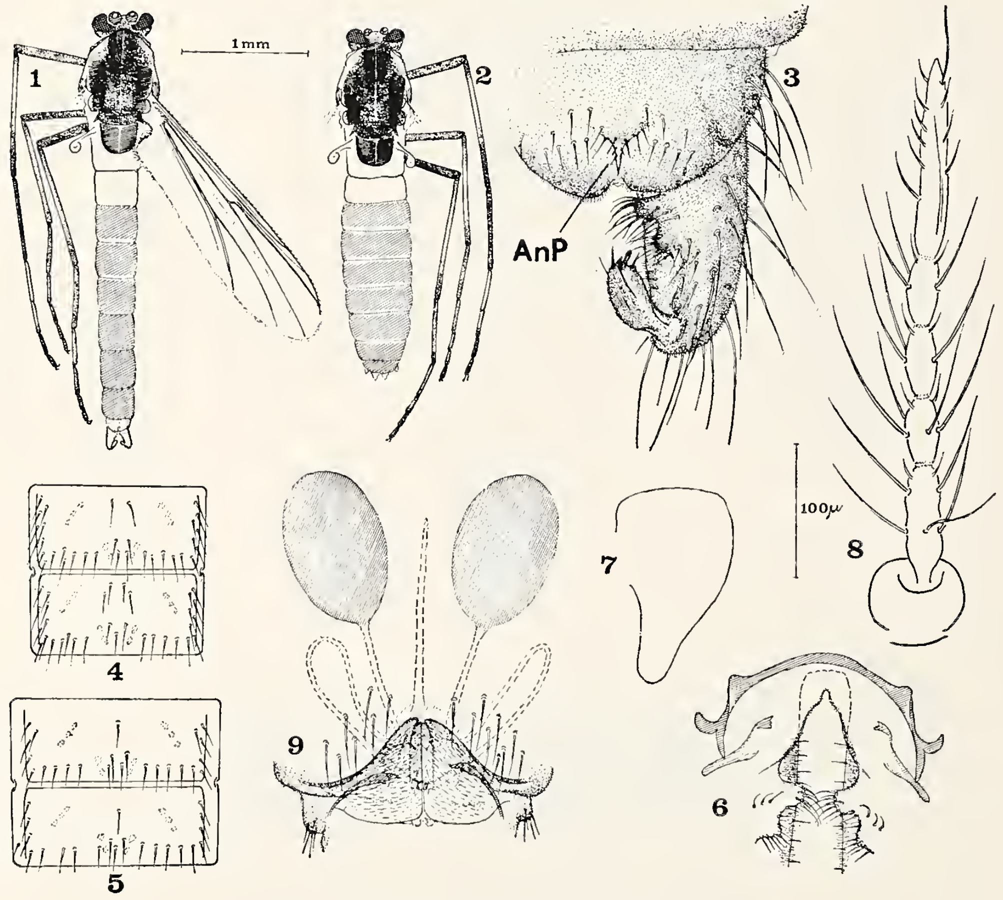


Figure 116. *Cricotopus* (*C.*) *claripes* Hirv., adult. ♂ (1); ♀ (2); hypopygium of ♂ (3); chaetotaxy scheme for abdominal tergites III and IV of ♂ (4); same (with Pts) of ♀ (5); aedeagal lobe and phallapodeme of hypopygium (6); cercus (7); antenna (8); outer genitalia of ♂ (9). Scale of drawings 1=2; 3=6–9.—AnP anal point.

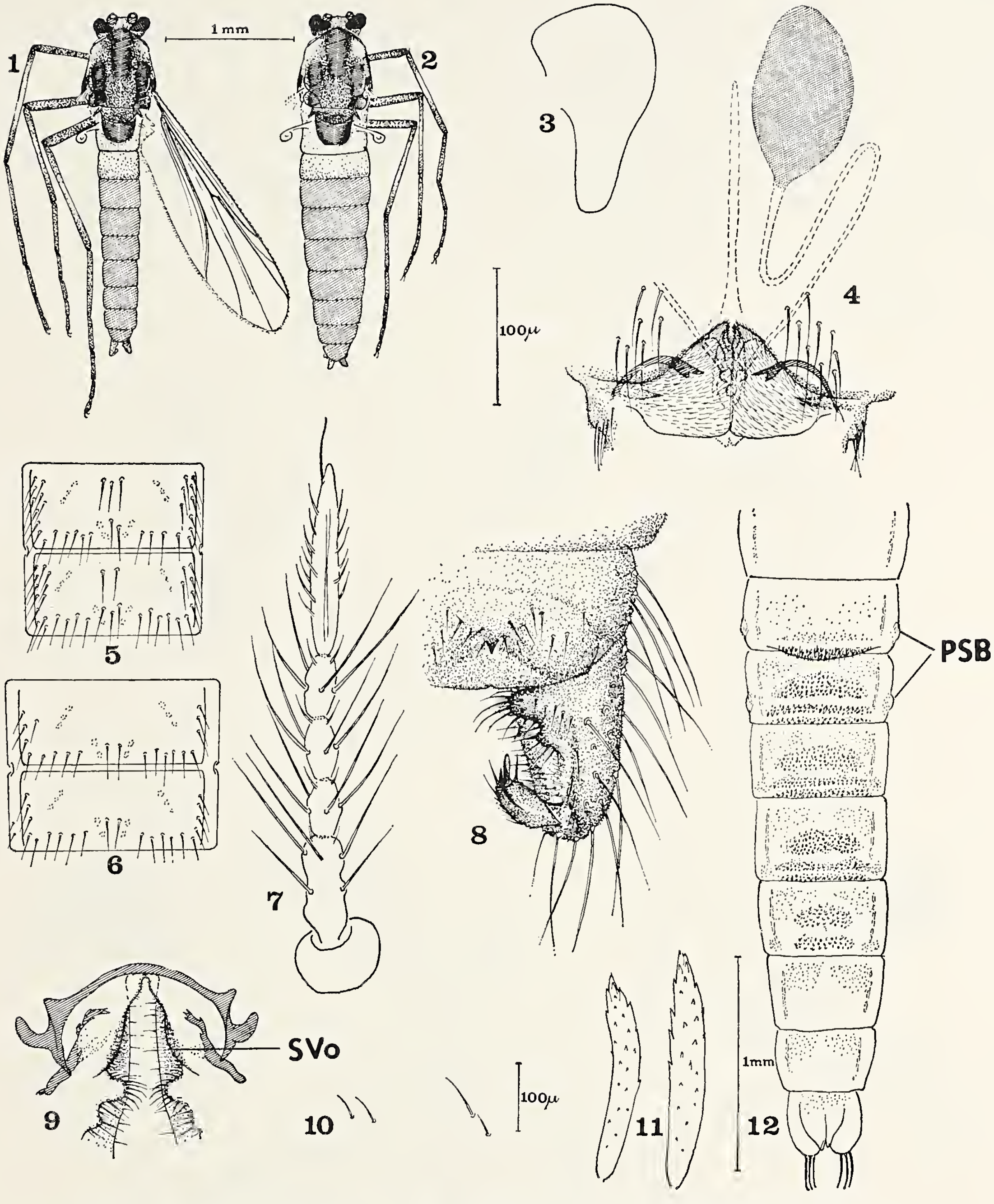


Figure 117. *Cricotopus* (*C.*) *tristis* Hirv., adult, pupa. ♂ (1); ♀ (2); cercus (3); spermatheca and outer genitalia of ♀ (4); chaetotaxy scheme for abdominal tergites III and IV of ♂ (5); same (with Pts) of ♀ (6); antenna of ♀ (7); hypopygium of ♂ (8); aedeagal lobe and phallapodeme of hypopygium (9); arrangement and size relationship of Dc_{1-4} (10); thoracic horn of pupa (11); abdominal tergites of pupa (12). Scale of drawings 1=2; 3=4, 7–9, 11.—PSB pedes spurii B, SVo superior volsella.

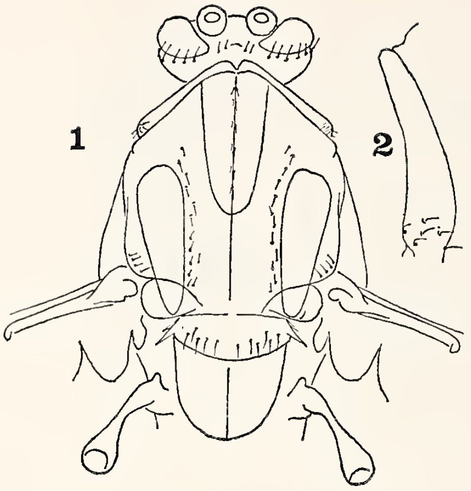


Figure 118. *Cricotopus* (*C.*) *curtus* Hirv., adult. Chaetotaxy scheme for head and thorax, dorsal (1); antepronotum, lateral (2).

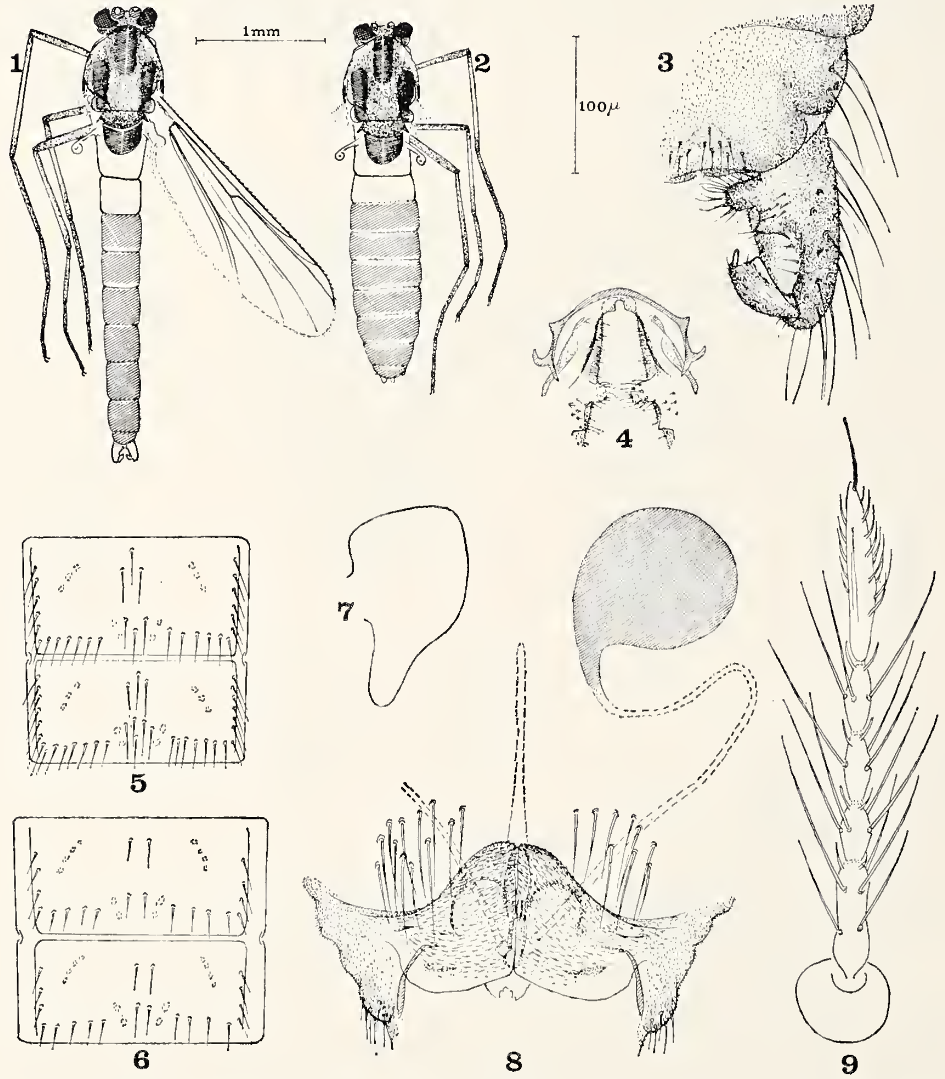


Figure 119. *Cricotopus* (*C.*) *curtus* Hirv., adult. ♂ (1); ♀ (2); hypopygium of ♂ (3); aedeagal lobe and phallapodeme of hypopygium (4); chaetotaxy scheme for abdominal tergites III and IV of ♂ (5); same of ♀ (6); cercus (7); spermatheca and outer genitalia of ♀ (8); antenna of ♀ (9). Scale of drawings 1=2; 3=4, 7−9.

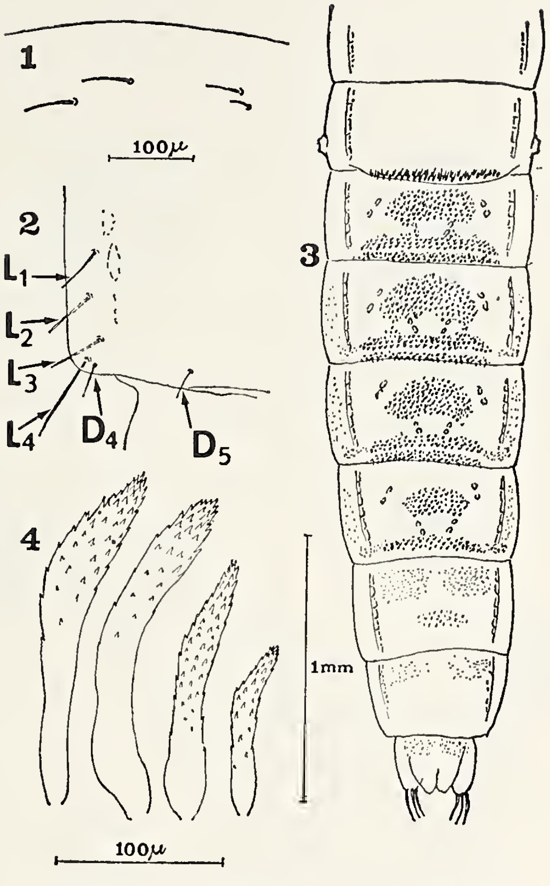


Figure 120. *Cricotopus* (*C.*) *curtus* Hirv., pupa. Arrangement and size relationship of Dc setae (1); setae on anal angle of segment VIII (2); shagreen of abdominal segments (3); thoracic horn (4).

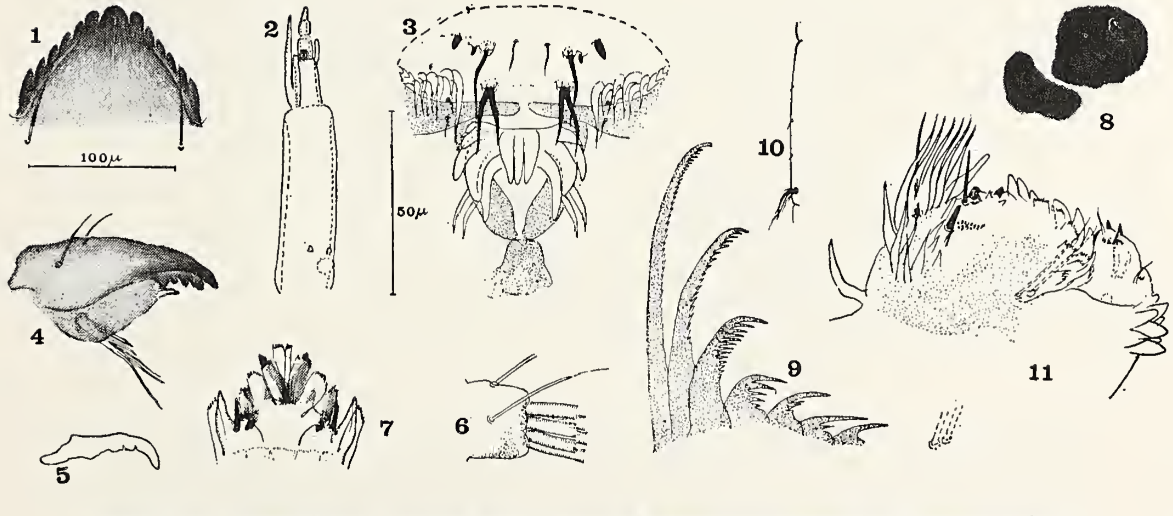


Figure 121. *Cricotopus* (*C.*) *curtus* Hirv., larva. Mentum (1); antenna (2); palatal surface of labrum (3); mandible (4); premandible (5); procercus (6); prementum (7); eyespots (8); claws of anterior parapods (9); L setae of abdominal segment IV (10); maxilla (11). Scale of drawings 1=4–5; 2=3, 6–9, 11; 10=1–2 of Figure 123.

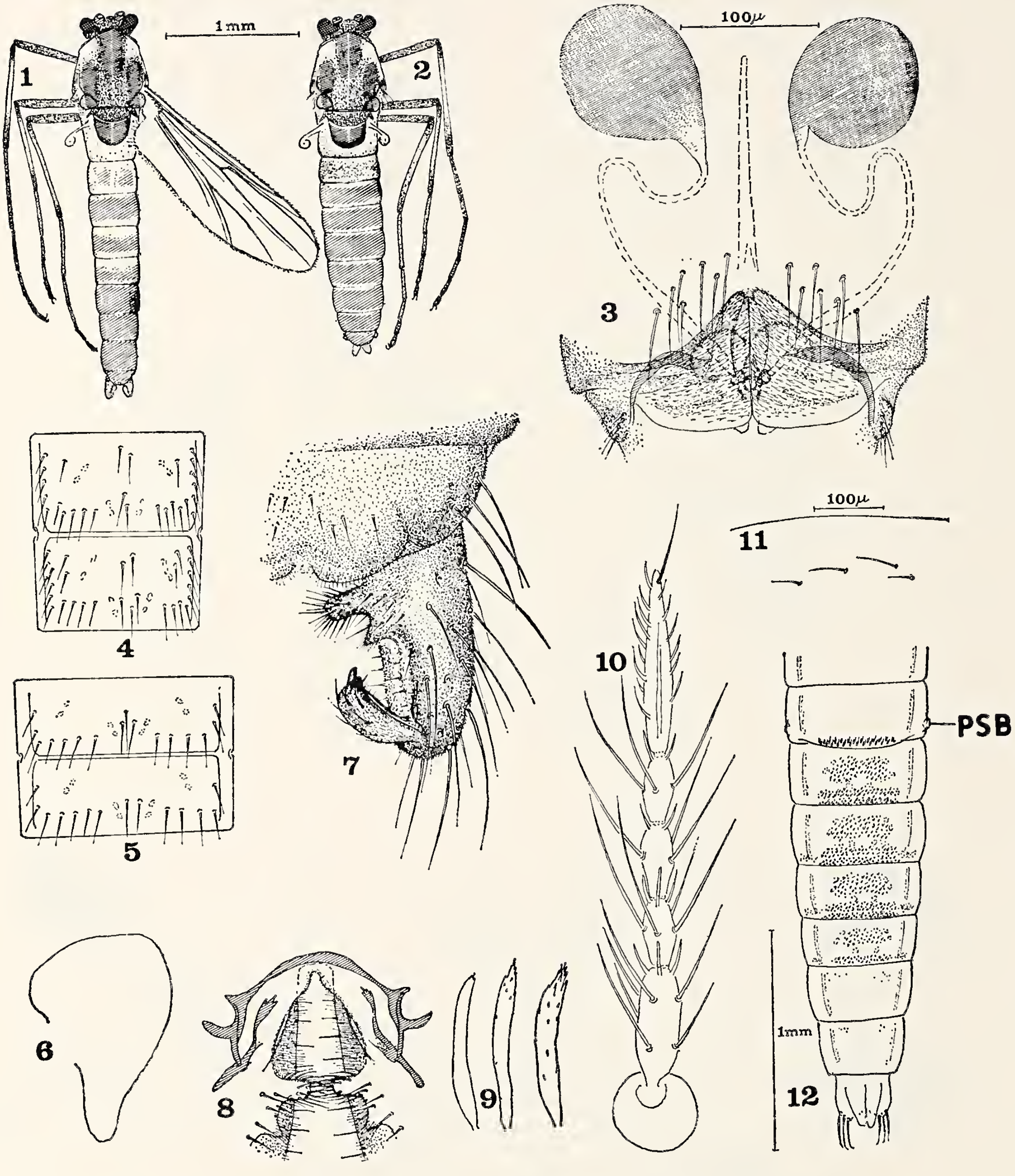


Figure 122. *Cricotopus* (*C.*) *annulator* Goetgh., adult, pupa. ♂ (1); ♀ (2); spermathecae and outer genitalia of ♀ (3); chaetotaxy scheme of abdominal tergites III and IV of ♂ (4); same of ♀ (5); cercus of ♀ (6); hypopygium of ♂ (7); aedeagal lobe and phallapodeme of hypopygium (8); thoracic horn of pupa (9); antenna of ♀ (10); size relationship and arrangement of Dc setae of pupa (11); shagreen of abdominal segments of pupa (12). Scale of drawings 1=2; 3=6–10.—PSB pedes spurii B.

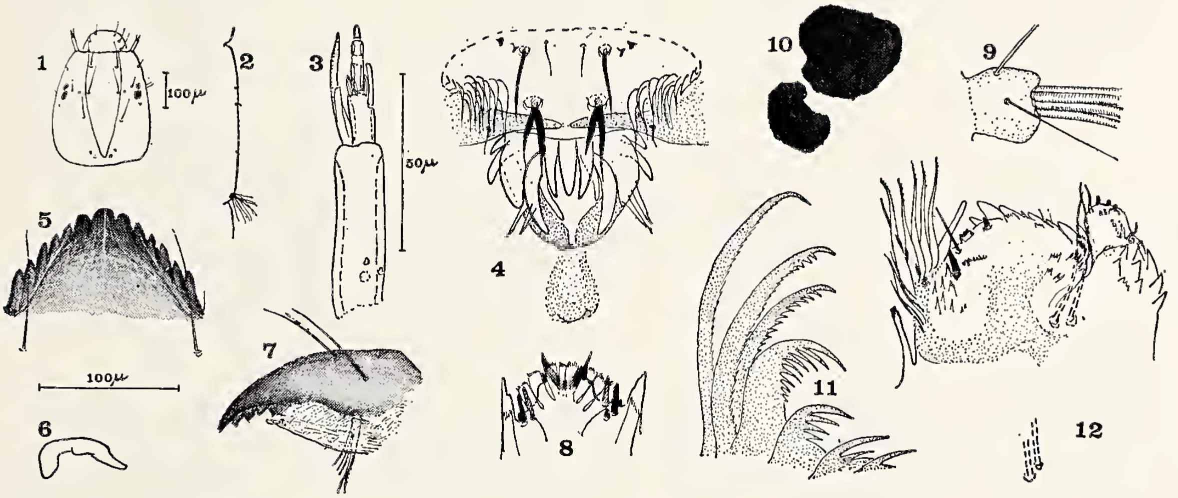


Figure 123. *Cricotopus* (*C.*) ?*annulator* Goetgh., larva from the *bituberculatus*-material of Thienemann. Head, dorsal (1); L setae of abdominal segment IV (2); antenna (3); palatal surface of labrum (4); mentum (5); premandible (6); mandible(7); prementum (8); procercus (9); eyespots (10); claws of anterior parapods (11); maxilla (12). Scale of drawings 1=2; 3=4, 8–12; 5=6–7.

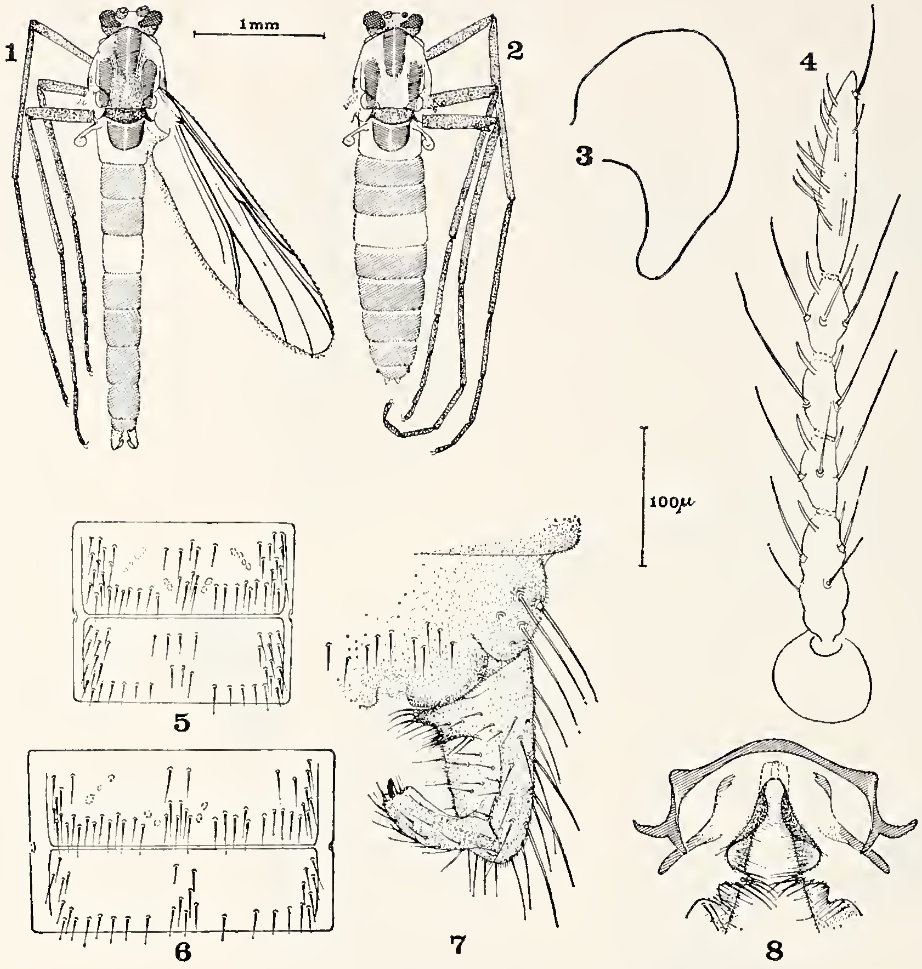
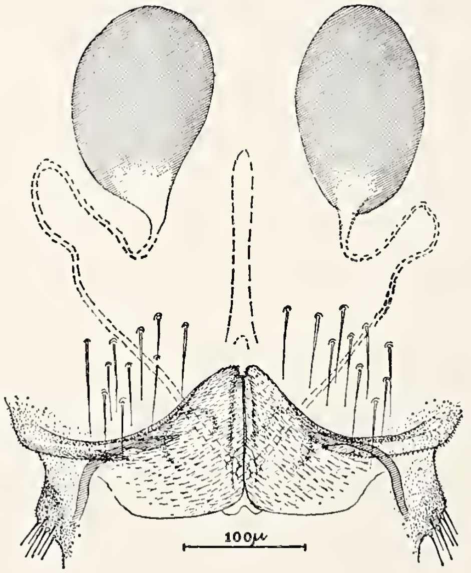


Figure 124. *Cricotopus* (*C.*) *beckeri* Hirv., adult. ♂ (1); ♀ (2); cercus of ♀ (3); antenna of ♀ (4); chaetotaxy scheme for abdominal segments III and IV of ♂ (5); same of ♀ (6); hypopygium of ♂ (7); aedeagal lobe and phallapodeme of hypopygium (8). Scale of drawings 1=2; 3=4, 7–8.

Figure 125. *Cricotopus* (*C.*) *beckeri* Hirv., spermathecae and outer genitalia of ♀.



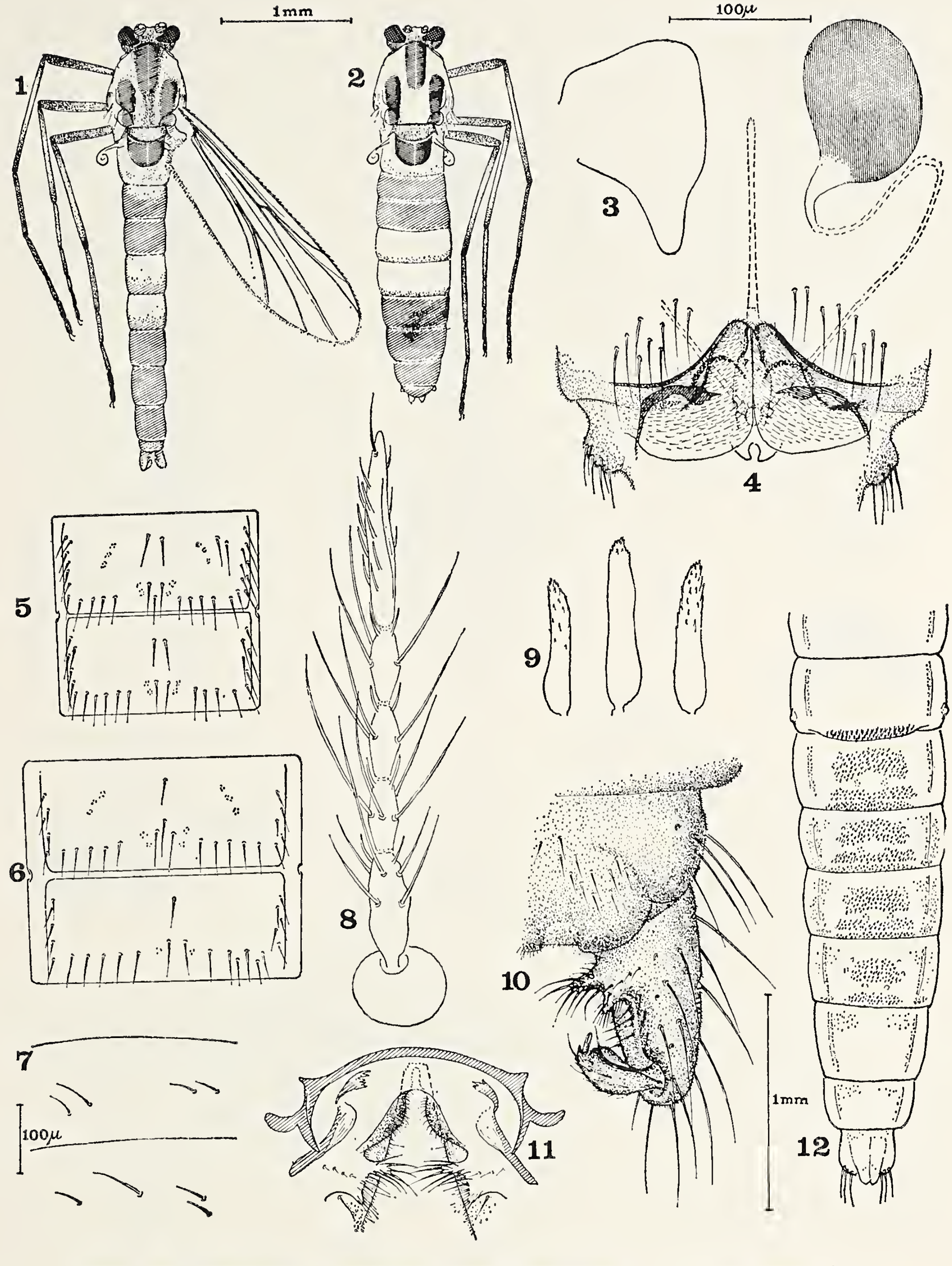


Figure 126. *Cricotopus* (*C.*) *triannulatus* (Macq.), adult, pupa. ♂ (1); ♀ (2); cercus of ♀ (3); spermatheca and outer genitalia of ♀ (4); chaetotaxy scheme for abdominal segments III and IV of ♂ (5); same of ♀ (6); variation in arrangement and size relationship of Dc setae of pupa (7); antenna of ♀ (8); thoracic horn of pupa (9); hypopygium of ♂ (10); aedeagal lobe and phallapodeme of hypopygium (11); shagreen of abdominal tergites of pupa (12). Scale of drawings 1=2; 3=4, 8−11.

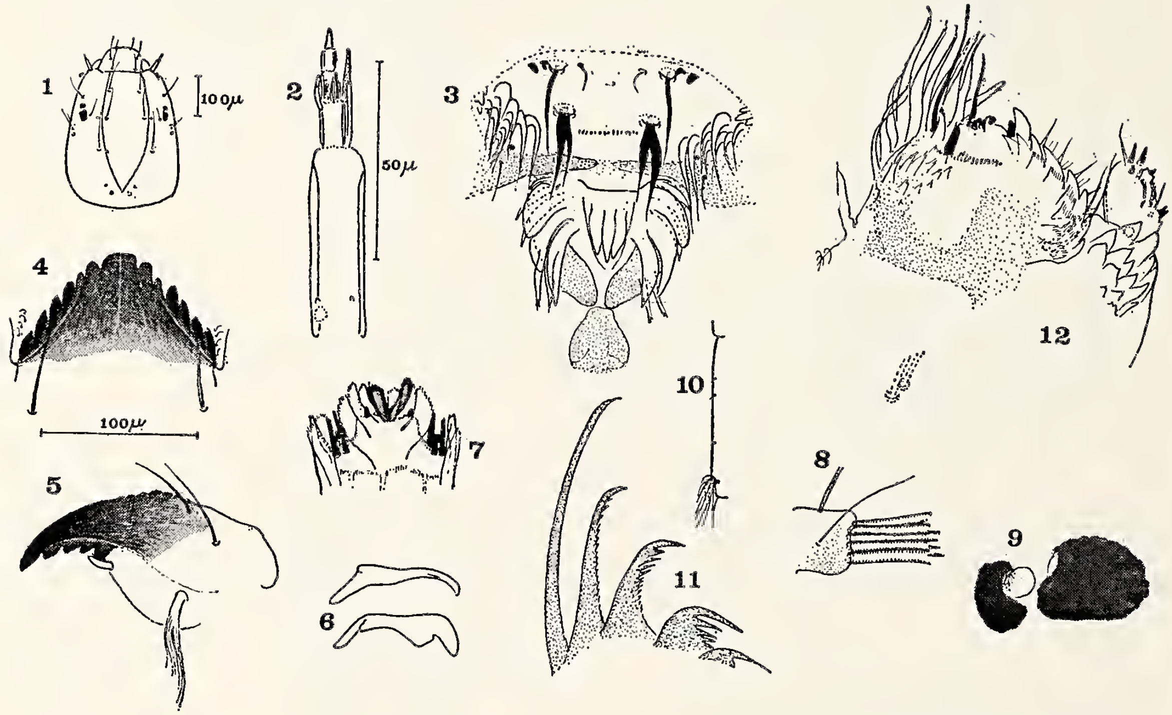


Figure 127. *Cricotopus* (*C.*) *triannulatus* (Macq.), larva. Head, dorsal (1); antenna (2); palatal surface of labrum (3); mentum (4); mandible (5); premandible (6); prementum (7); procercus (8); eyespots (9); L setae of abdominal segment III (10); claws of anterior parapods (11); maxilla (12). Scale of drawings 1=10; 2=3, 7–9, 11–12; 4=5–6.

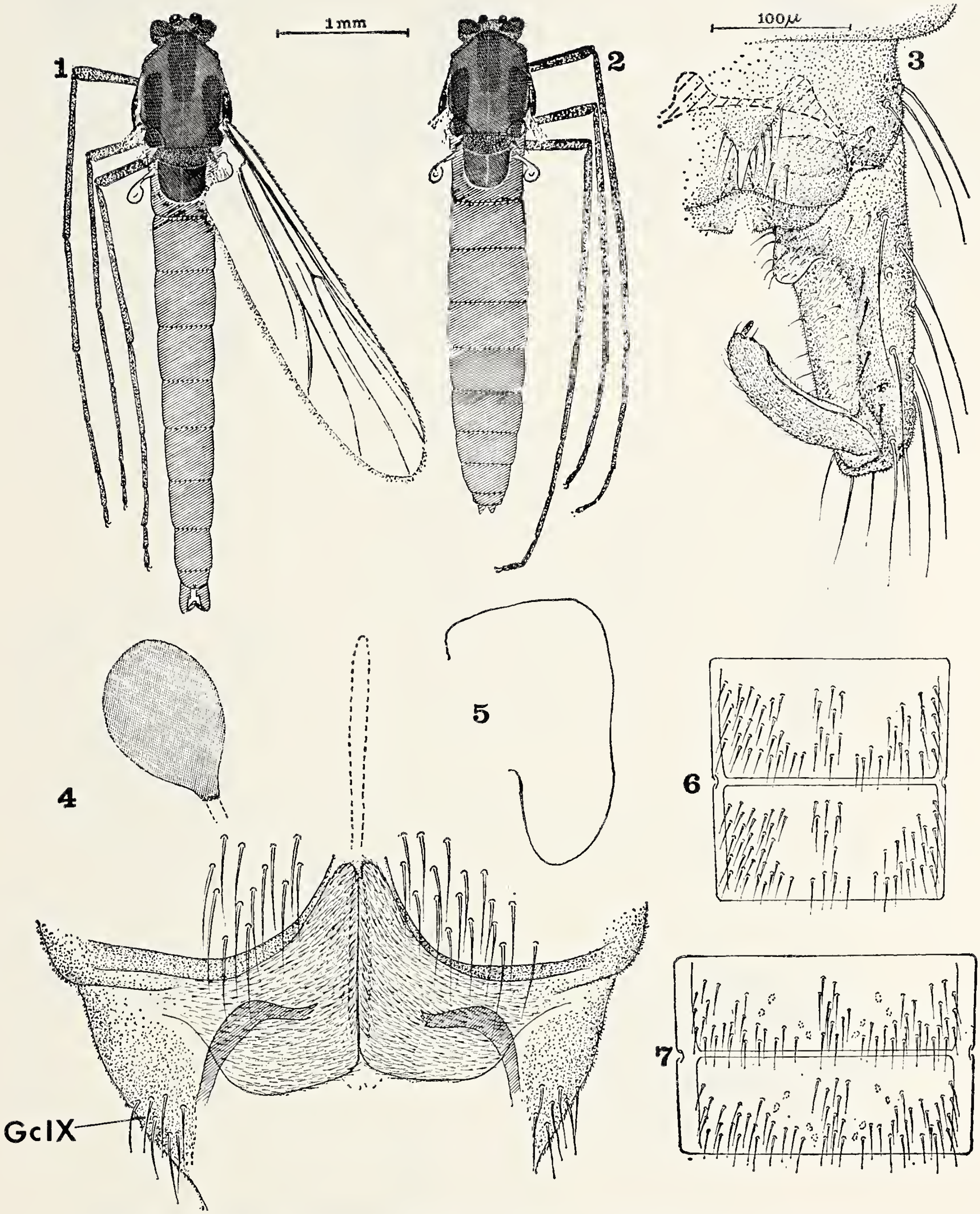


Figure 128. *Cricotopus* (*Nostococladius*) *lygropis* Edw., adult (Holotype ♀; placement of ♂ not certain). ♂ (1); ♀ (2); hypopygium of ♂ (3); spermatheca and outer genitalia of ♀ (4); cercus of ♀ (5); chaetotaxy for abdominal tergites III and IV of ♂ (6); same of ♀ (7). Scale of drawings 1=2; 3=4−5.—Gc IX gonocoxite IX.

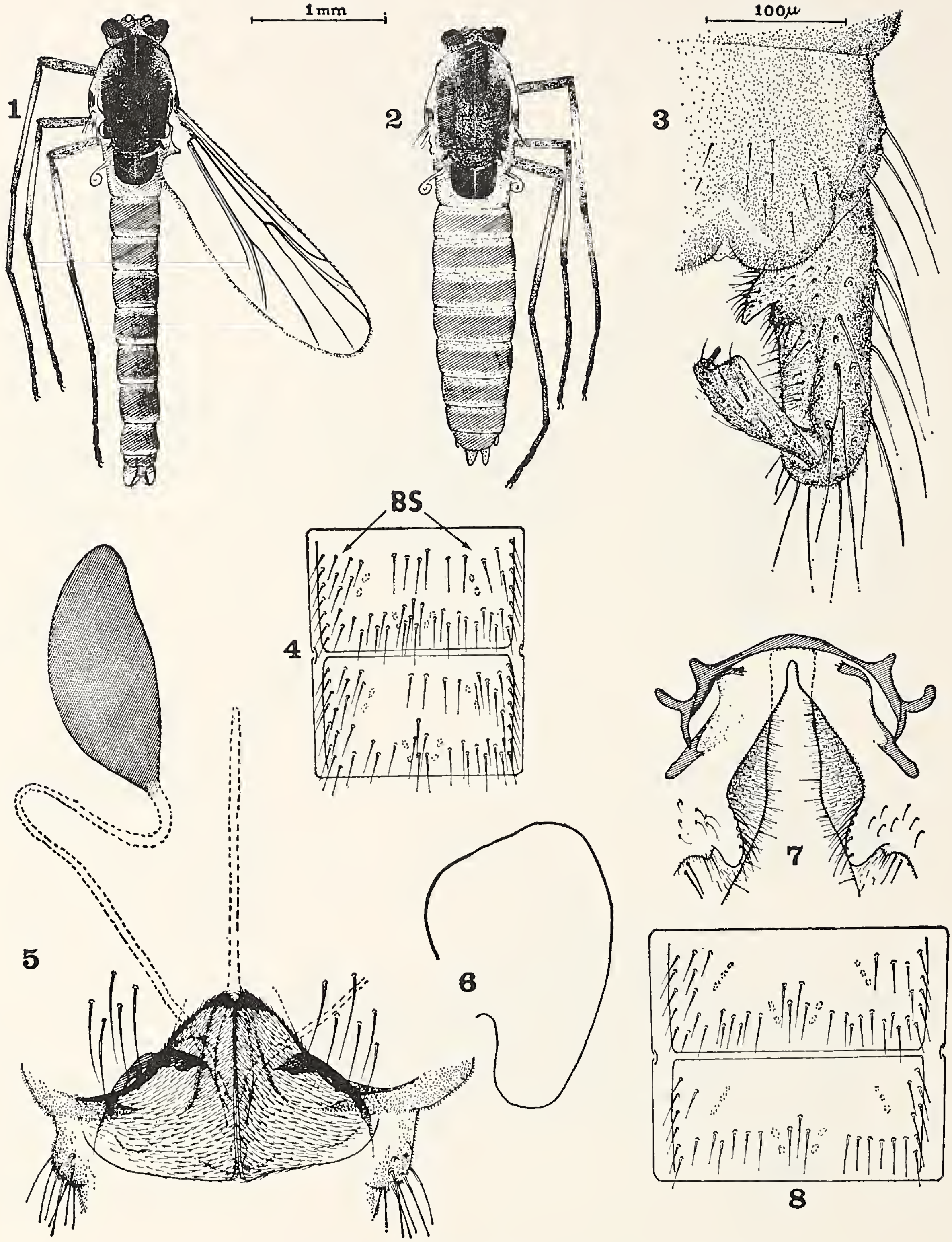


Figure 129. *Cricotopus* (*C.*) *cylindraceus* (Kieff.), adult. ♂ (1); ♀ (2); hypopygium of ♂ (3); chaetotaxy scheme for abdominal tergites III and IV of ♂ (4); spermatheca and outer genitalia of ♀ (5); cercus of ♀ (6); aedeagal lobe and phallapodeme of hypopygium (7);chaetotaxy scheme for abdominal tergites III and IV of ♀ (8). Scale of drawings 1=2; 3=5–7.—BS basal setae.

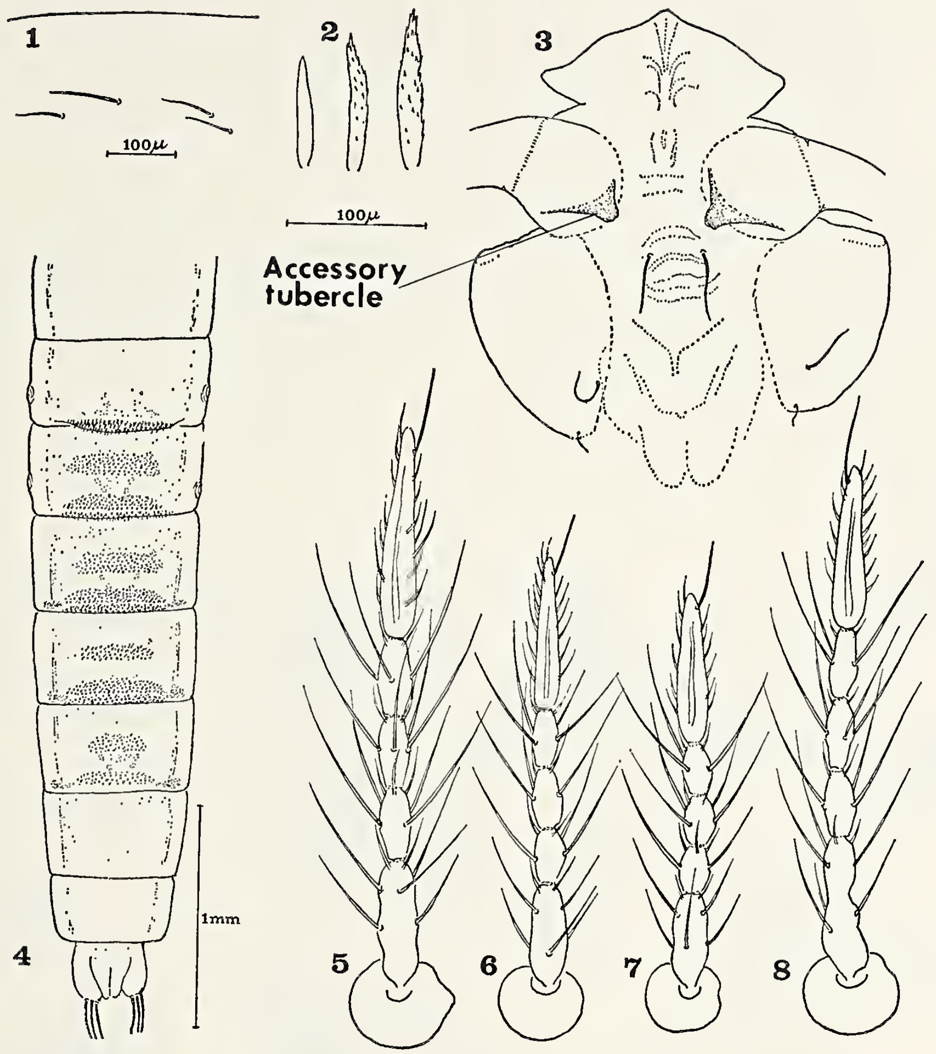


Figure 130. *Cricotopus* (*C.*) *cylindraceus* (Kieff.), adult, pupa. Size relationship and arrangement of Dc setae (1); thoracic horn (2); region of head seen from front, above, frontal apotome, laterally antennal bases and ocular field (3); abdominal segments of pupa (4); antenna of ♀ (5). Antenna of ♀ of *C.* (*C.*) *coronatus* Hirv. (6); same of *C.* (*C.*) *patens* Hirv. (7); same of *C.* (*C.*) *festivellus* (Kieff.) (8). Scale of drawings 1=3; 2=5−8.

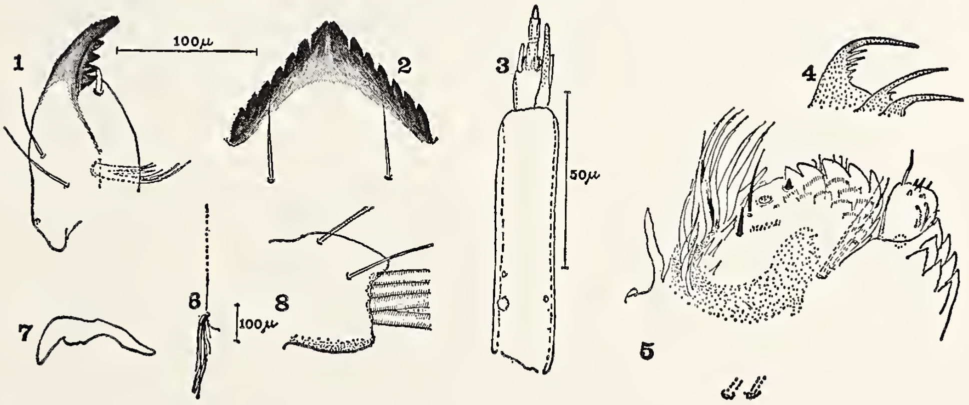


Figure 131. *Cricotopus* (*C.*) *cylindraceus* (Kieff.), larva. Mandible (1); mentum (2); antenna (3); some of the smaller claws of anterior parapods (4); maxilla (5); L_4 of abdominal segment ?IV (6); premandible (7); procercus (8). Scale of drawings 1=2, 7; 3=4−5, 8.

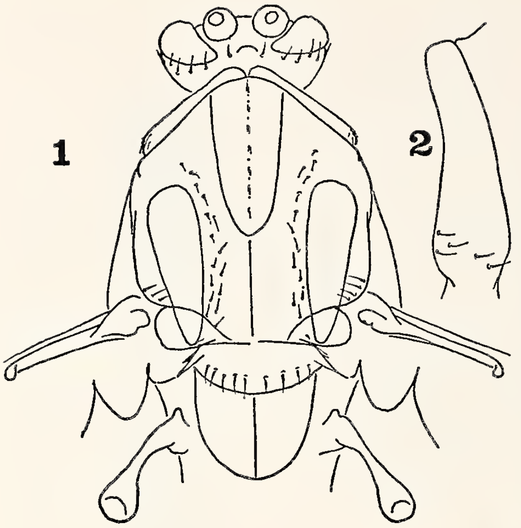


Figure 132. *Cricotopus* (*C.*) *patens* Hirv., adult. Chaetotaxy scheme of head and thorax, dorsal (1); antepronotum, lateral (2).

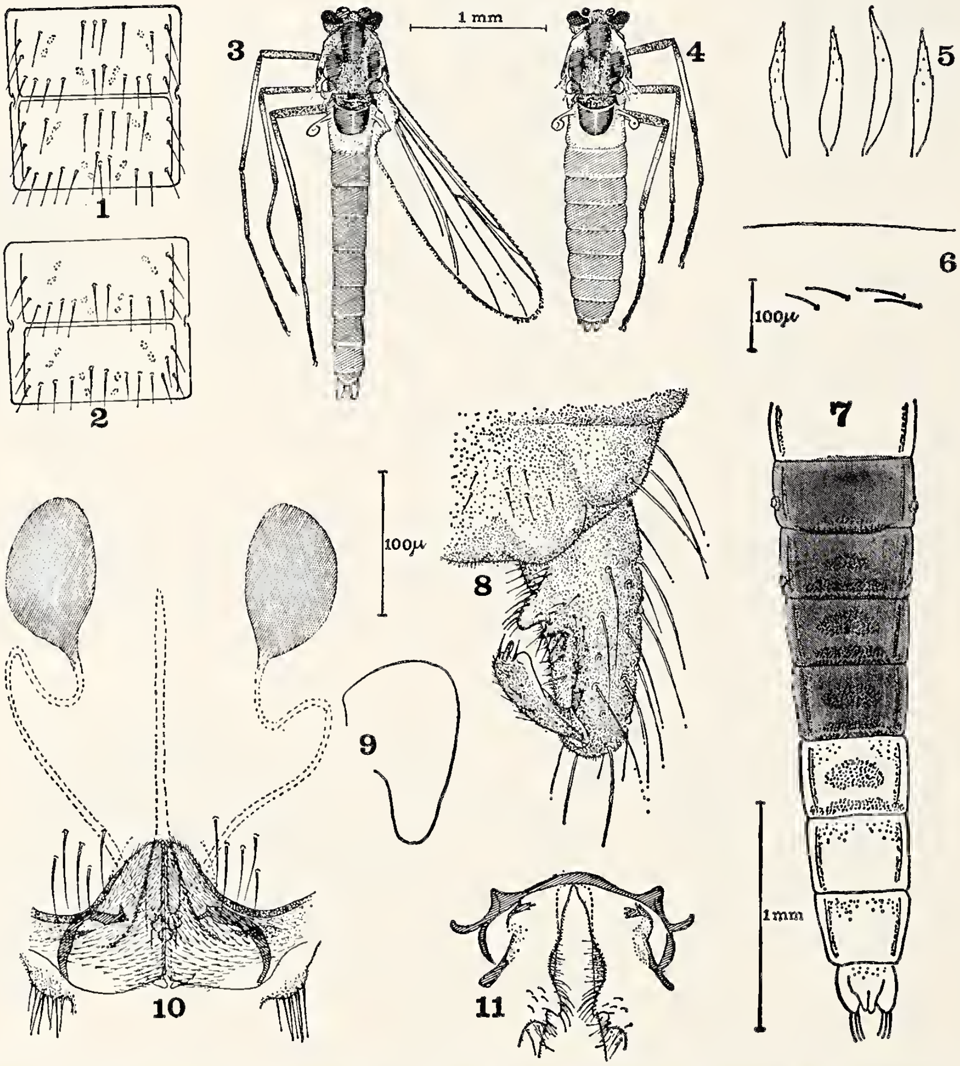


Figure 133. *Cricotopus* (*C.*) *patens* Hirv., adult, pupa. Chaetotaxy scheme for abdominal tergites III and IV of ♂ (1); same of ♀ (2); ♂ (3); ♀ (4); thoracic horn (5); size relationship and arrangement of Dc setae of pupa (6); abdominal segments of pupa (7); hypopygium of ♂ (8); cercus of ♀ (9); spermathecae and outer genitalia of ♀ (10); aedeagal lobe and phallapodeme of hypopygium (11). Scale of drawings 3=4; 5=8–11.

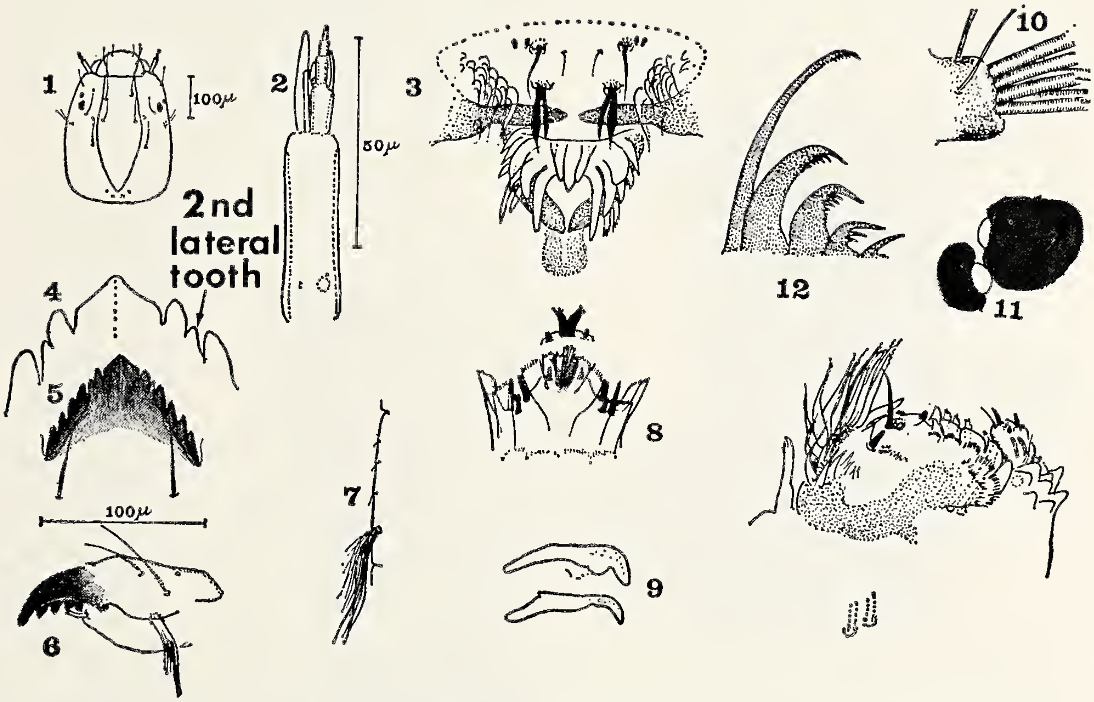


Figure 134. *Cricotopus* (*C.*) *patens* Hirv., larva. Head, dorsal (1); antenna (2); palatal surface of labrum (3); median tooth and first three lateral teeth of mentum (4); mentum (5); mandible (6); L setae of abdominal segment IV (7); prementum (ligula drawn above, separated) (8); premandible (9); procercus (10); eyespots (11); claws of anterior parapods (12); maxilla (13). Scale of drawings 1=7; 2=3–4, 8, 10–13; 5=6, 9.

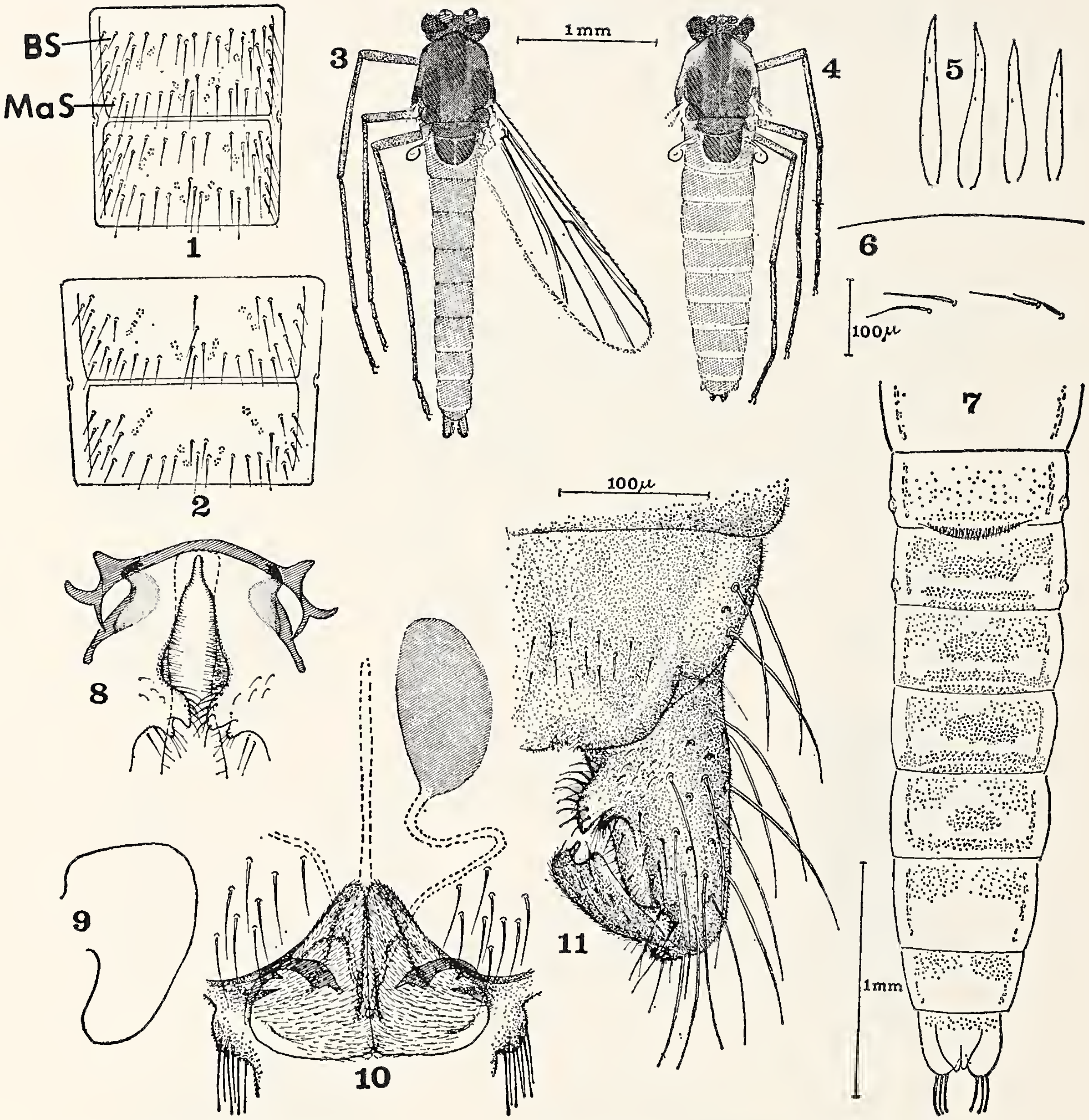


Figure 135. *Cricotopus* (*C.*) *coronatus* Hirv., adult, pupa. Chaetotaxy scheme for abdominal tergites III and IV of ♂ (1); same of ♀ (2); ♂ (3); ♀ (4); variation in thoracic horn (5); size relationship and arrangement of Dc setae of pupa (6); abdominal segments of pupa (7); aedeagal lobe and phallapodeme of hypopygium (8); cercus of ♀ (9); spermatheca and outer genitalia of ♀ (10); hypopygium of ♂ (11). Scale of drawings 3=4; 5=8–11. BS transverse row of basal setae, MaS transverse row of marginal setae.

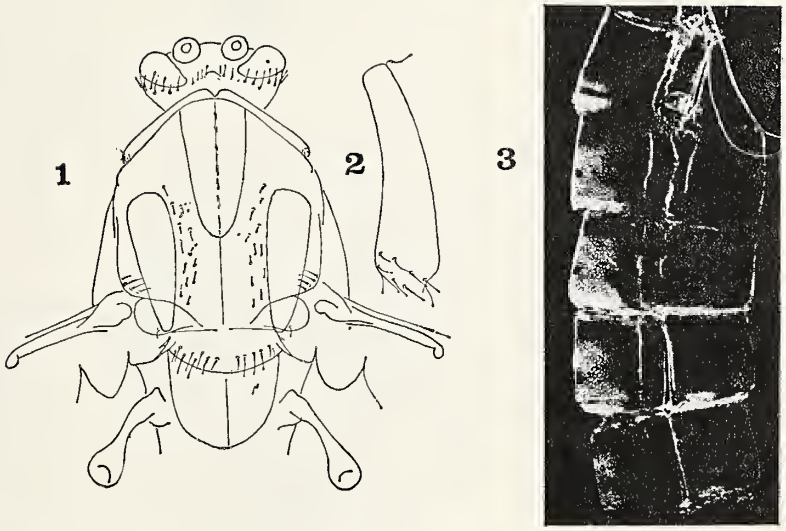


Figure 136. *Cricotopus* (*C.*) *festivellus* (Kieff.). Chaetotaxy scheme for head and thorax, dorsal (1); and antepronotum, lateral (2) of adult; abdominal segments II–VI of pupal exuvium, lateral (dark field photography) (3).

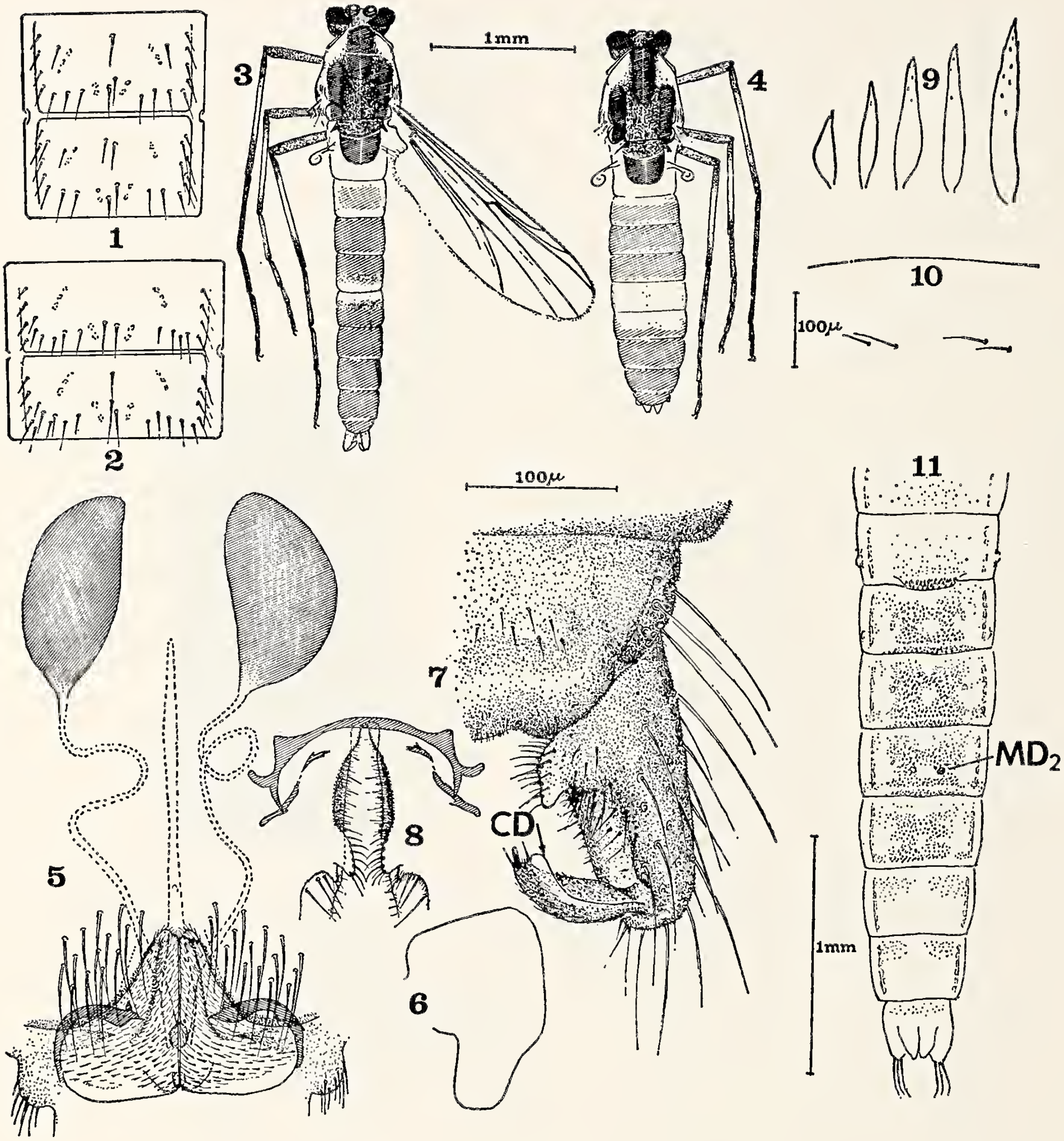


Figure 137. *Cricotopus* (*C.*) *festivellus* (Kieff.), adult, pupa. Chaetotaxy scheme for abdominal tergites III and IV of ♂ (1); same of ♀ (2); ♂ (3); ♀ (4); spermathecae and outer genitalia of ♀ (5); cercus of ♀ (6); hypopygium of ♂ (7); aedeagal lobe and phallapodeme of hypopygium (8); variation in thoracic horn (9); size relationship and arrangement of the Dc setae of pupa (10); abdominal segments of pupa (11). Scale of drawings 3=4; 5=6−9. CD crista dorsalis, MD_2 posteromedian muscle marks.

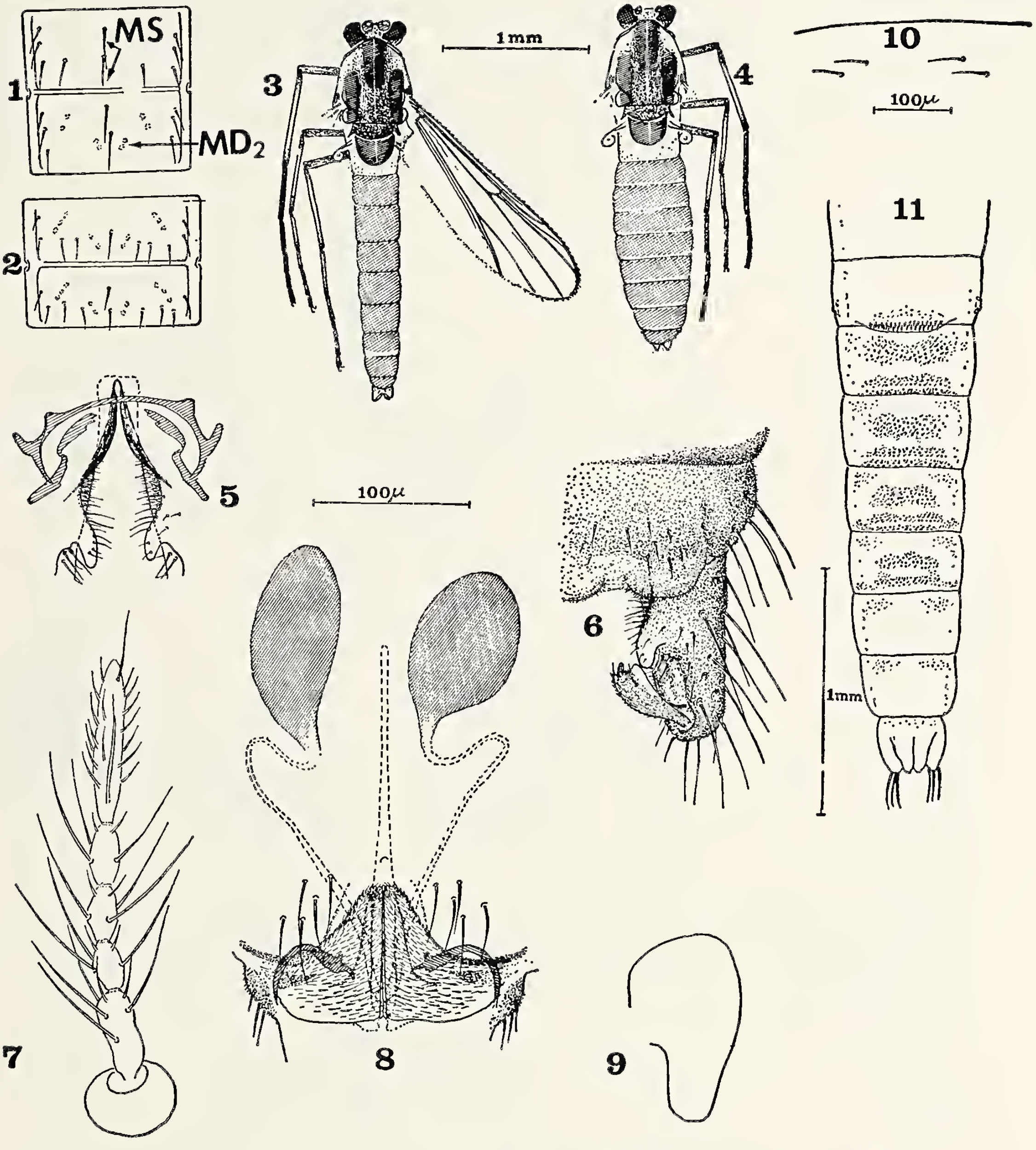


Figure 138. *Cricotopus* (*C.*) *flavocinctus* (Kieff.), adult, pupa. Chaetotaxy scheme for abdominal tergites III and IV of ♂ (1); same of ♀ (2); ♂ (3); ♀ (4); aedeagal lobe and phallapodeme of hypopygium (5); hypopygium (6); antenna (7); spermathecae and outer genitalia of ♀ (8); cercus of ♀ (9); size relationship and arrangement of Dc setae of pupa (10); abdominal tergites of pupa (11). Scale of drawings 3=4; 5=6−9.—MD$_2$ posteromedian muscle marks, MS median setae.

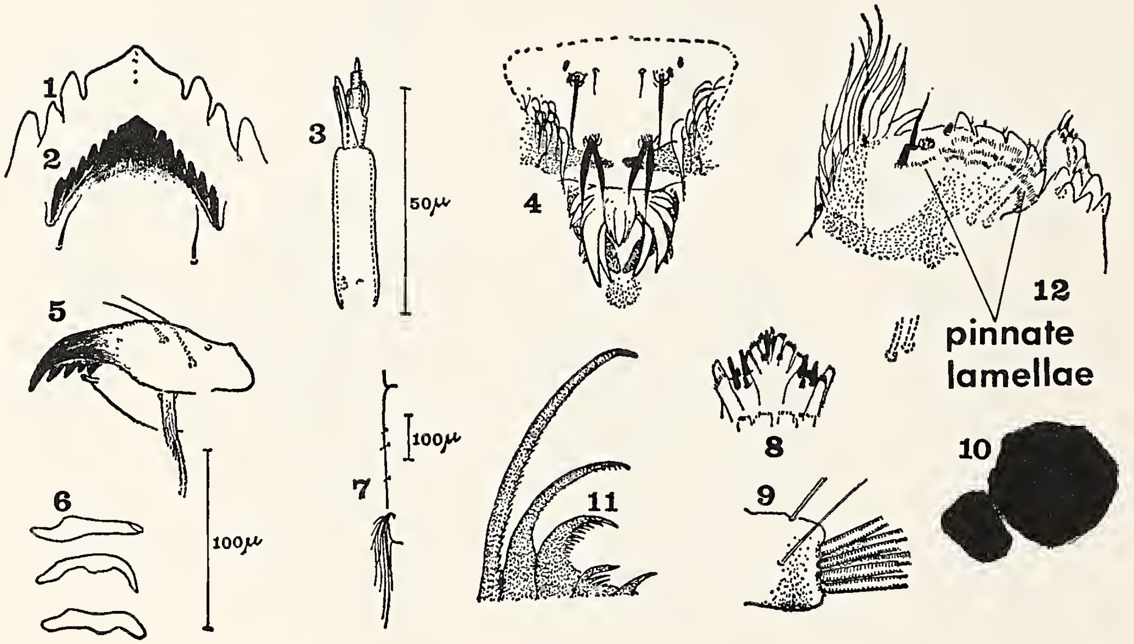


Figure 139. *Cricotopus* (*C.*) *flavocinctus* (Kieff.), larva. Median tooth and first three lateral teeth of mentum (1); mentum (2); antenna (3); palatal surface of labrum (4); mandible (5); premandible (6); L setae of abdominal segment IV (7); prementum (8); procercus (9); eyespots (10); claws of anterior parapods (11); maxilla (12). Scale of drawings 1=3–4, 8–12; 2=5–6.

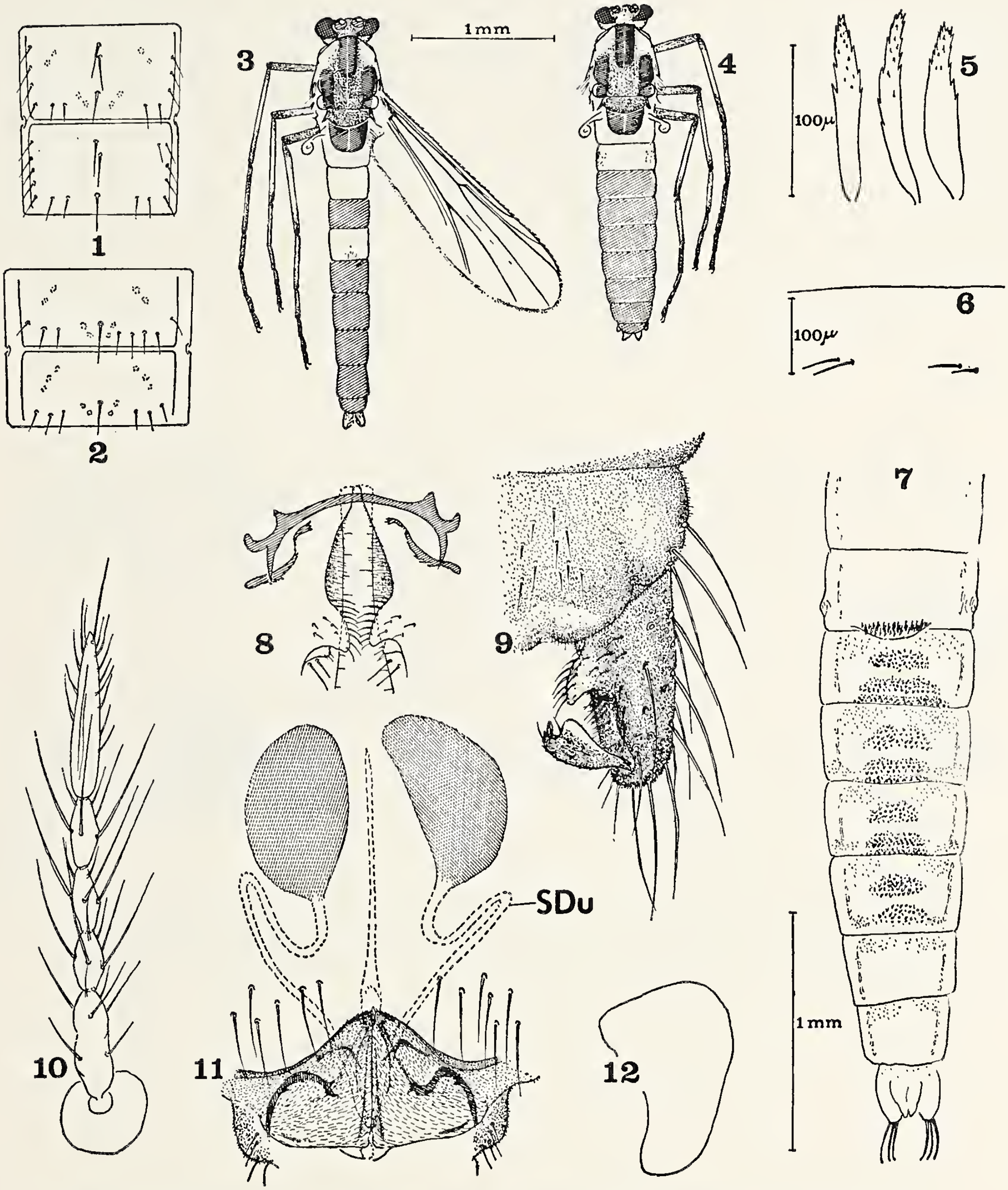


Figure 140. *Cricotopus* (*C.*) *albiforceps* (Kieff.), adult, pupa. Chaetotaxy scheme for abdominal tergites III and IV of ♂ (1); same of ♀ (2); ♂ (3); ♀ (4); thoracic horn (5); size relationship and arrangement of Dc setae of pupa (6); abdominal segments of pupa (7); aedeagal lobe and phallapodeme of hypopygium (8); hypopygium (9); antenna (10); spermathecae and outer genitalia of ♀ (11); cercus of ♀ (12). Scale of drawings 3=4; 5=8−12. — SDu spermathecal duct.

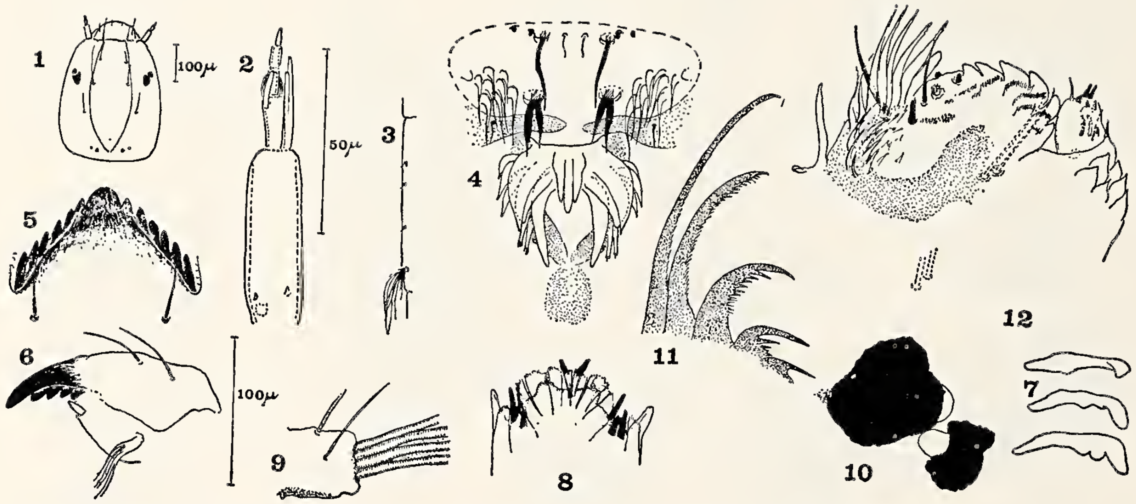


Figure 141. *Cricotopus (C.) albiforceps* (Kieff.), larva. Head, dorsal (1); antenna (2); L setae of abdominal segment IV (3); palatal surface of labrum (4); mentum (5); mandible (6); premandible (7); prementum (8); procercus (9); eyespots (10); claws of anterior parapods (11); maxilla (12). Scale of drawings 1=3; 2=4, 8–12; 5=6–7.

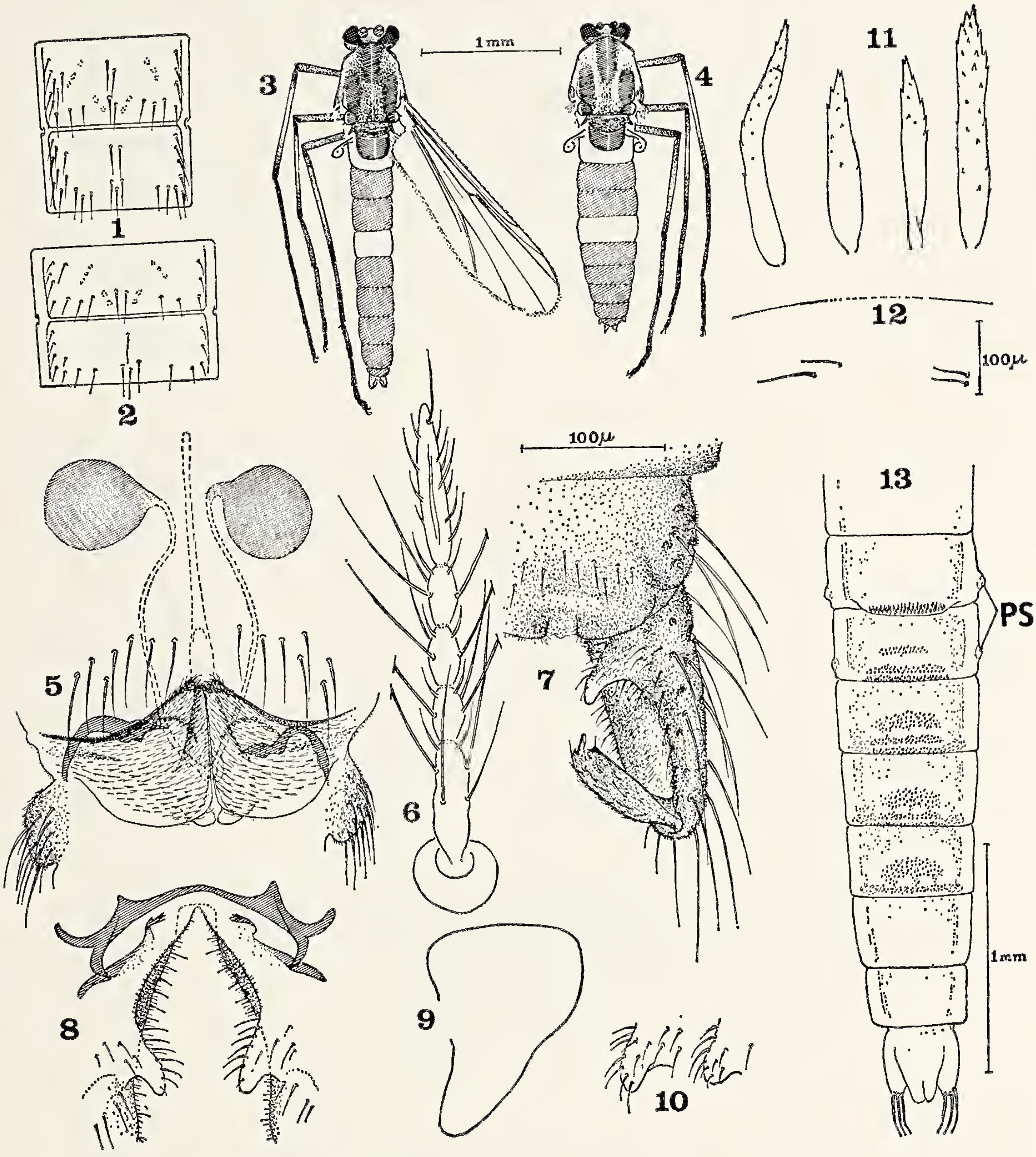


Figure 142. *Cricotopus (C.) bicinctus* (Meig.), adult, pupa. Chaetotaxy scheme for abdominal tergites III and IV of ♂ (1); same of ♀ (2); ♂ (3); ♀ (4); spermathecae and outer genitalia of ♀ (5); antenna of ♀ (6); hypopygium of ♂ (7); aedeagal lobe and phallapodeme of hypopygium (8); cercus of ♀ (9); inferior volsella of a population from Mutenianjoki, Finnish-Lappland (10); variation in thoracic horn (populations from Mutenianjoki, left, Tammisaari in the middle, and Tvärminne, right) (11); size relationship and arrangement of Dc setae of pupa (12); shagreen of abdominal segments (pigmentation about as in Figure 57 or 169) of pupa (13). Scale of drawings 3=4; 5=8−11.—PSB pedes spurii B.

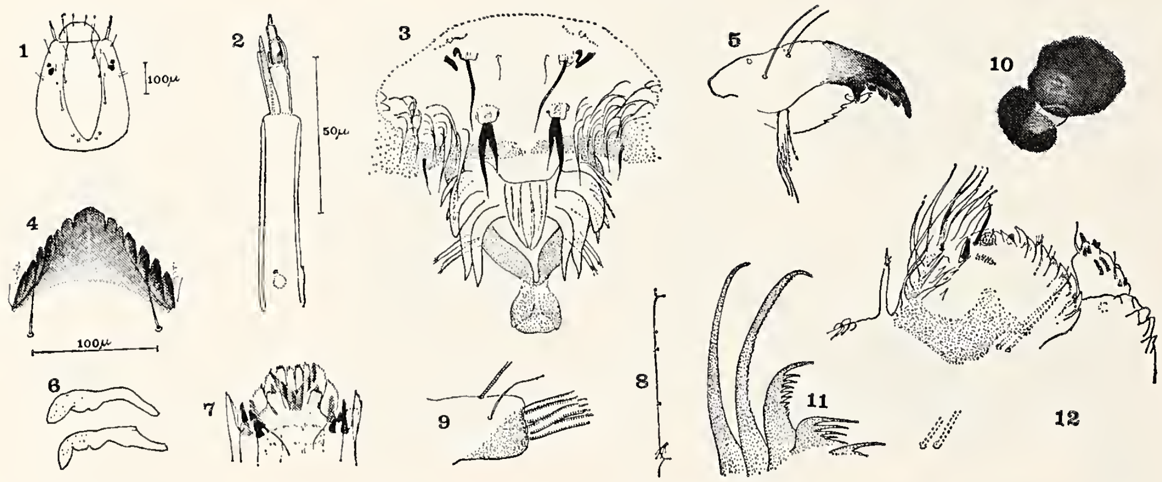


Figure 143. *Cricotopus (C.) bicinctus* (Meig.), larva. Head, dorsal, (1); antenna (2); palatal surface of labrum (3); mentum (4); mandible (5); premandible (6); prementum (7); L setae of abdominal segment V (8); procercus (9); eyespots (10); claws of anterior parapods (11); maxilla (12). Scale of drawings 1=8; 2=3, 7, 9–12; 4=5–6.

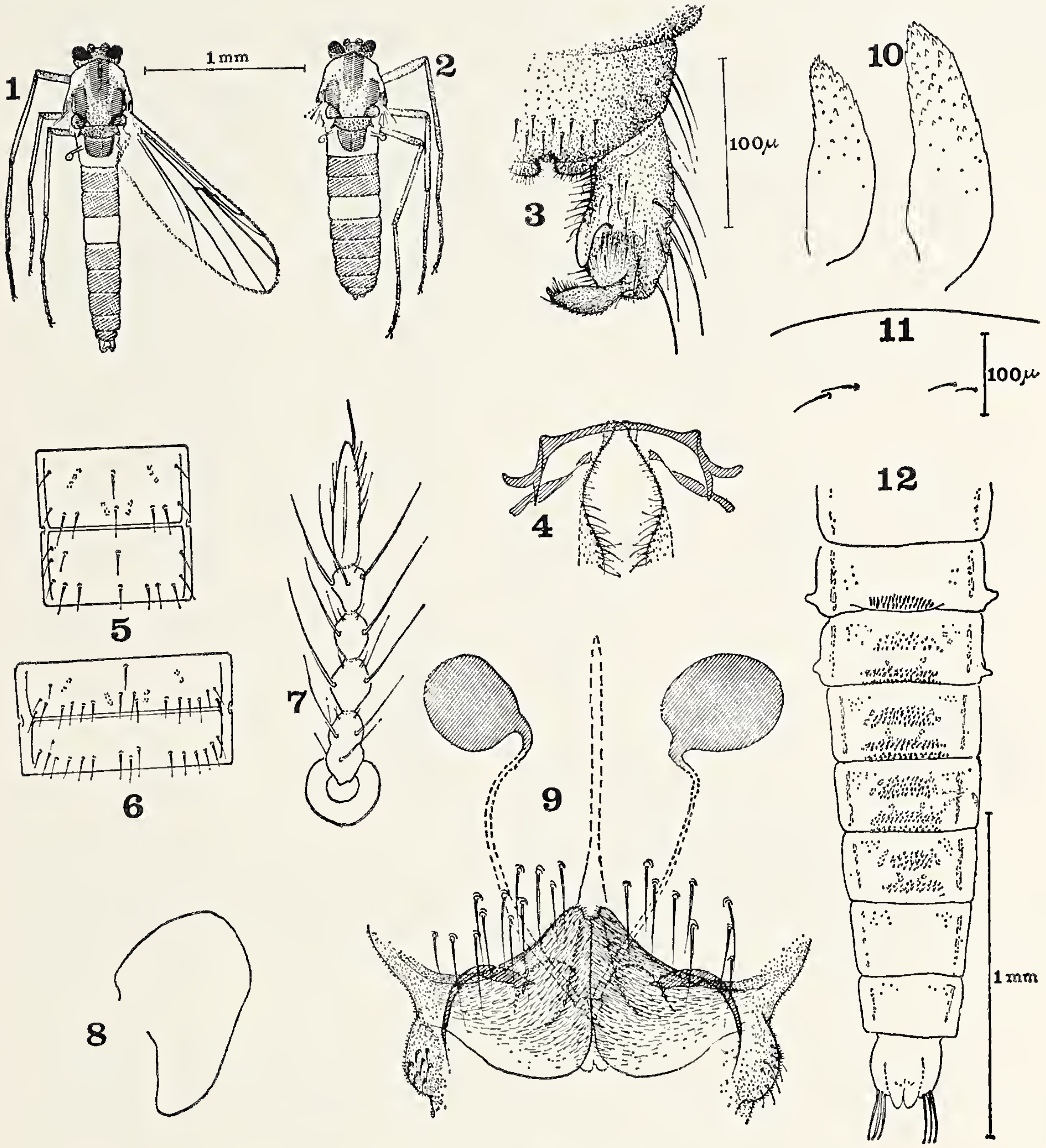


Figure 144. *Cricotopus (C.) vierriensis* Goetgh., adult, pupa. ♂ (1); ♀ (2); hypopygium (3); aedeagal lobe and phallapodeme of hypopygium (4); chaetotaxy scheme for abdominal tergites III and IV of ♂ (5); same of ♀ (6); antenna (7); cercus of ♀ (8); spermathecae and outer genitalia of ♀ (9); thoracic horn (10); size relationship and arrangement of Dc setae of pupa (11); abdominal segments of pupa (12). Scale of drawings 1=2; 3=4, 7–10.

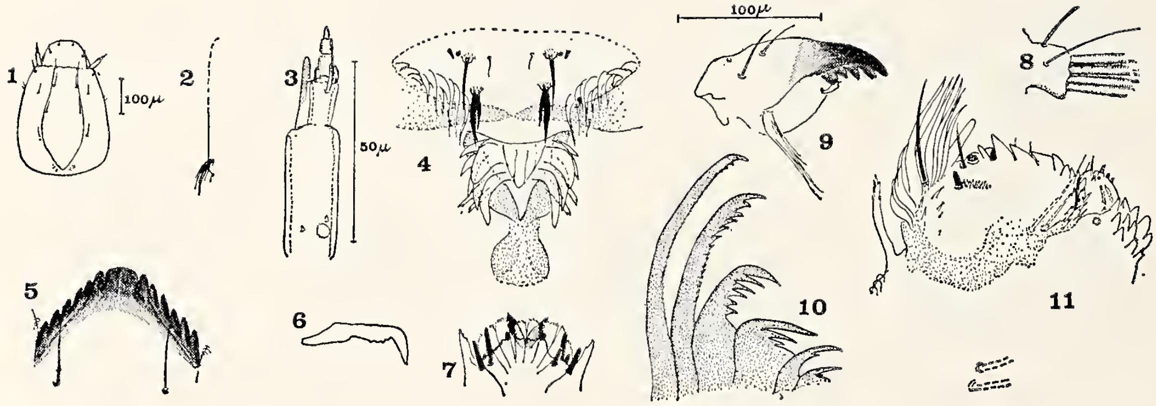


Figure 145. ***Cricotopus (C.) vierriensis*** **Goetgh., larva. Head, dorsal (1); L_4 from one of the middle abdominal segments (2); antenna (3); palatal surface of labrum (4); mentum (5); premandible (6); prementum (7); procercus (8); mandible (9); claws of anterior parapods (10); maxilla (11). Scale of drawings 1=2; 3=4, 7−8, 10−11; 5=6, 9.**

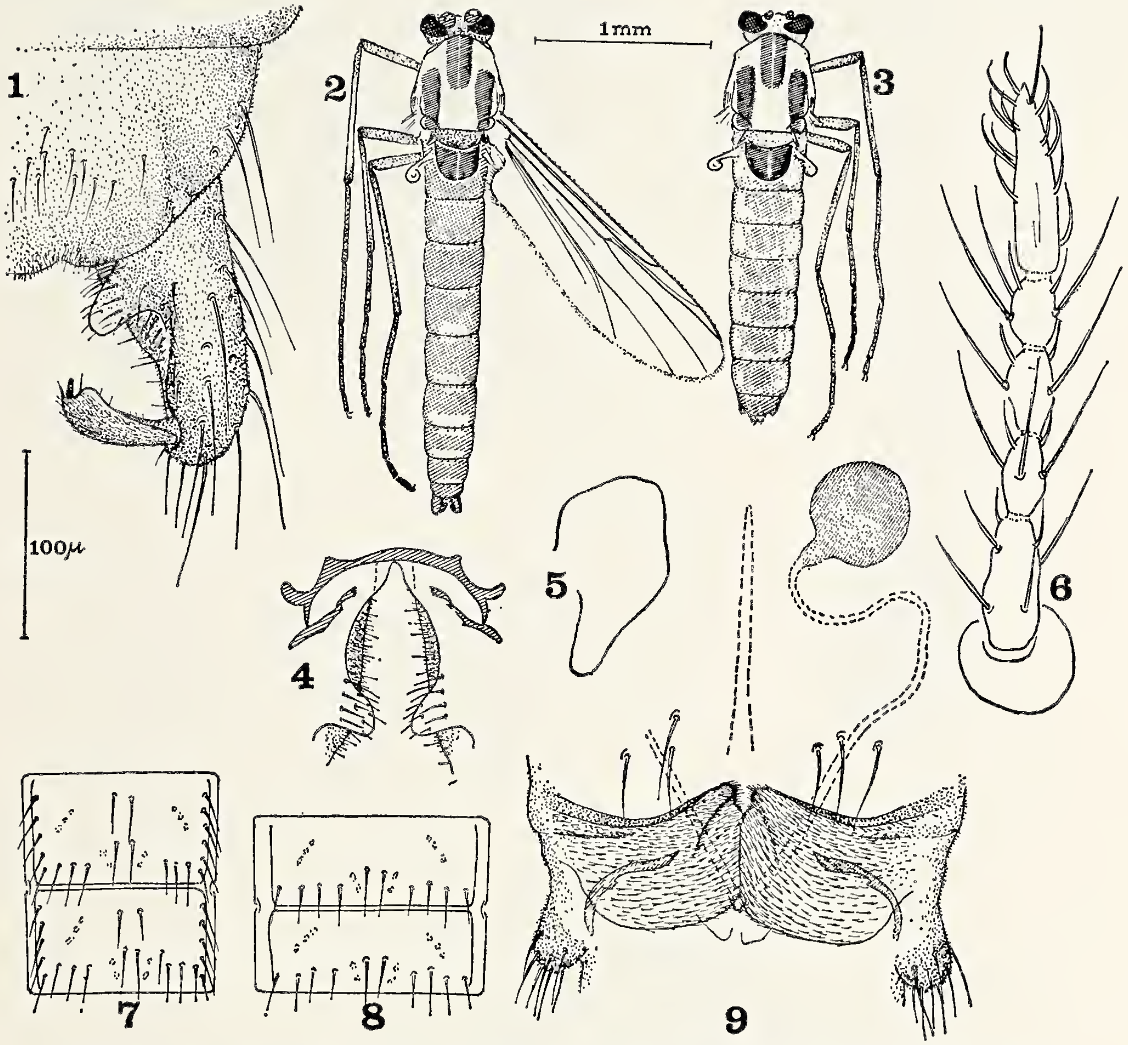


Figure 146. *Cricotopus (C.) pallidipes* Edw., adult. Hypopygium of ♂ (1); ♂ (2); ♀ (3); aedeagal lobe and phallapodeme of hypopygium (4); cercus of ♀ (5); antenna of ♀ (6); chaetotaxy scheme for abdominal tergites III and IV of ♂ (7); same of ♀ (8); spermathecae and outer genitalia of ♀ (9); Scale of drawings 1=4−6, 9; 2=3.

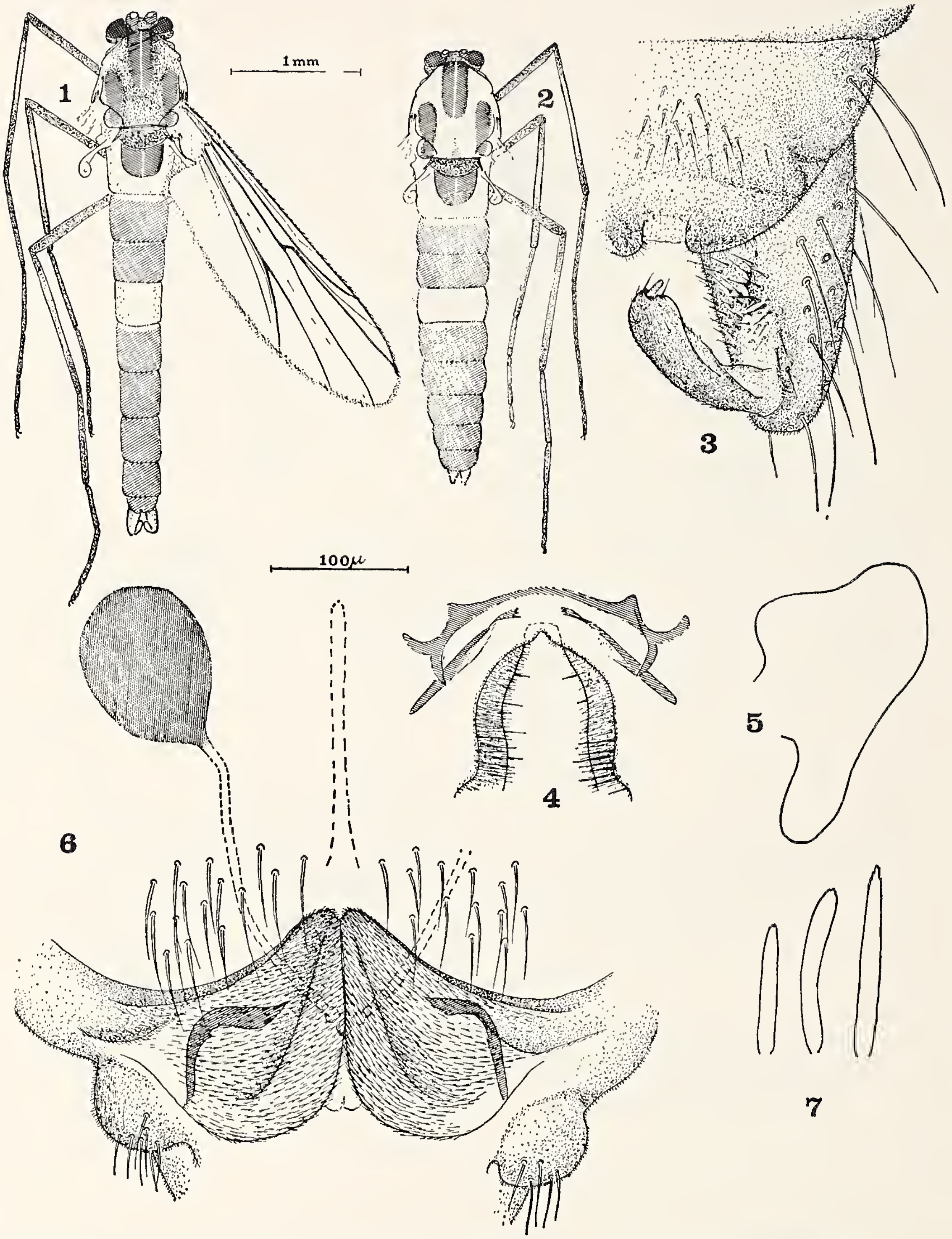


Figure 147. *Cricotopus (C.) trifascia* Edw., adult, pupa. ♂ (1); ♀ (2); hypopygium (3); aedeagal lobe and phallapodeme of hypopygium (4), cercus of ♀ (5); spermatheca and outer genitalia of ♀ (6); thoracic horn of pupa (7). Scale of drawings 1=2; 3=4−7.

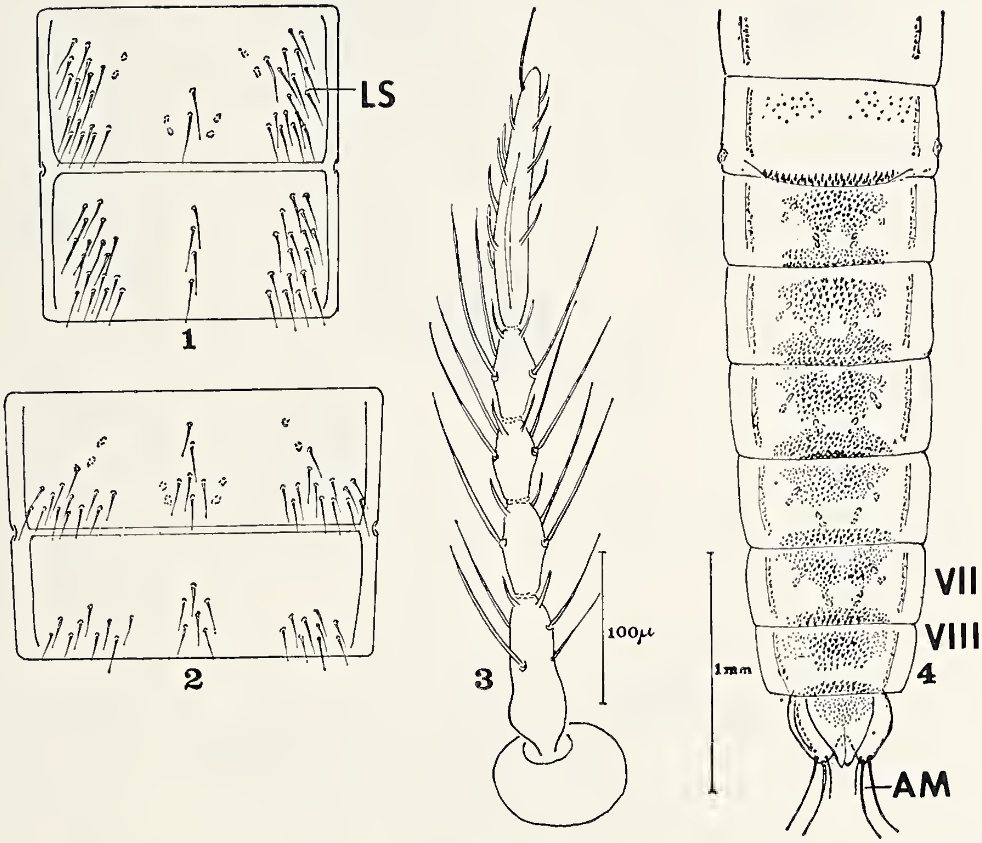


Figure 148. *Cricotopus (C.) trifascia* Edw., adult, pupa. Chaetotaxy scheme for abdominal tergites III and IV of ♂ (1); same of ♀ (2); antenna of ♀ (3); shagreen of abdominal tergites of pupa (4).—AM anal macrosetae, LS lateral setae.

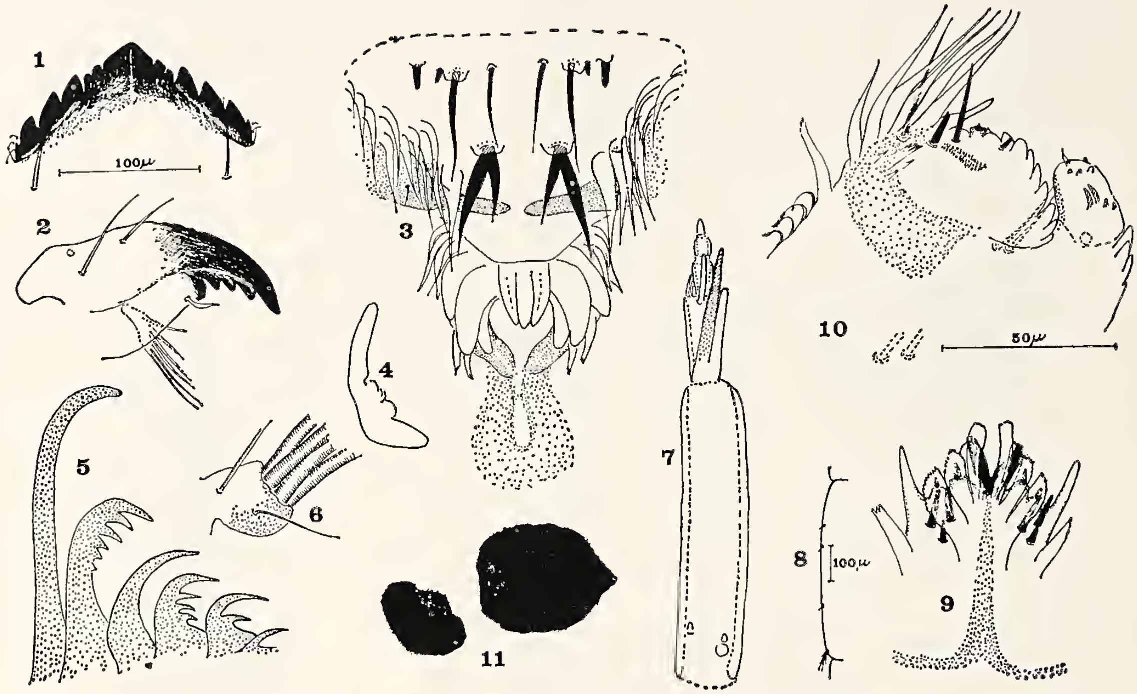


Figure 149. *Cricotopus (C.) trifascia* Edw., larva. Mentum (1); mandible (2); palatal surface of labrum (3); premandible (4); claws of anterior parapods (5); procercus (6); antenna (7); L setae of abdominal segment IV (8); prementum (9); maxilla (10); eyespots (11). Scale of drawings 1=2, 4; 3=5–7, 9–11.

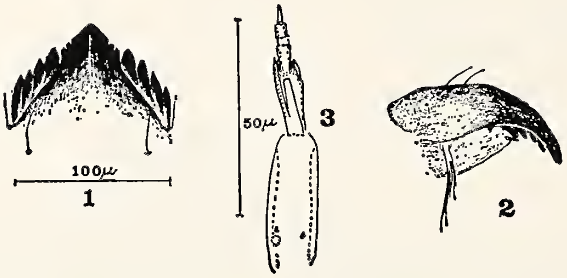


Figure 150. *Cricotopus (C.) trifascia* Edw., ? early instar larva: mentum (1); mandible (2); antenna (3). Scale of drawings 1=2.

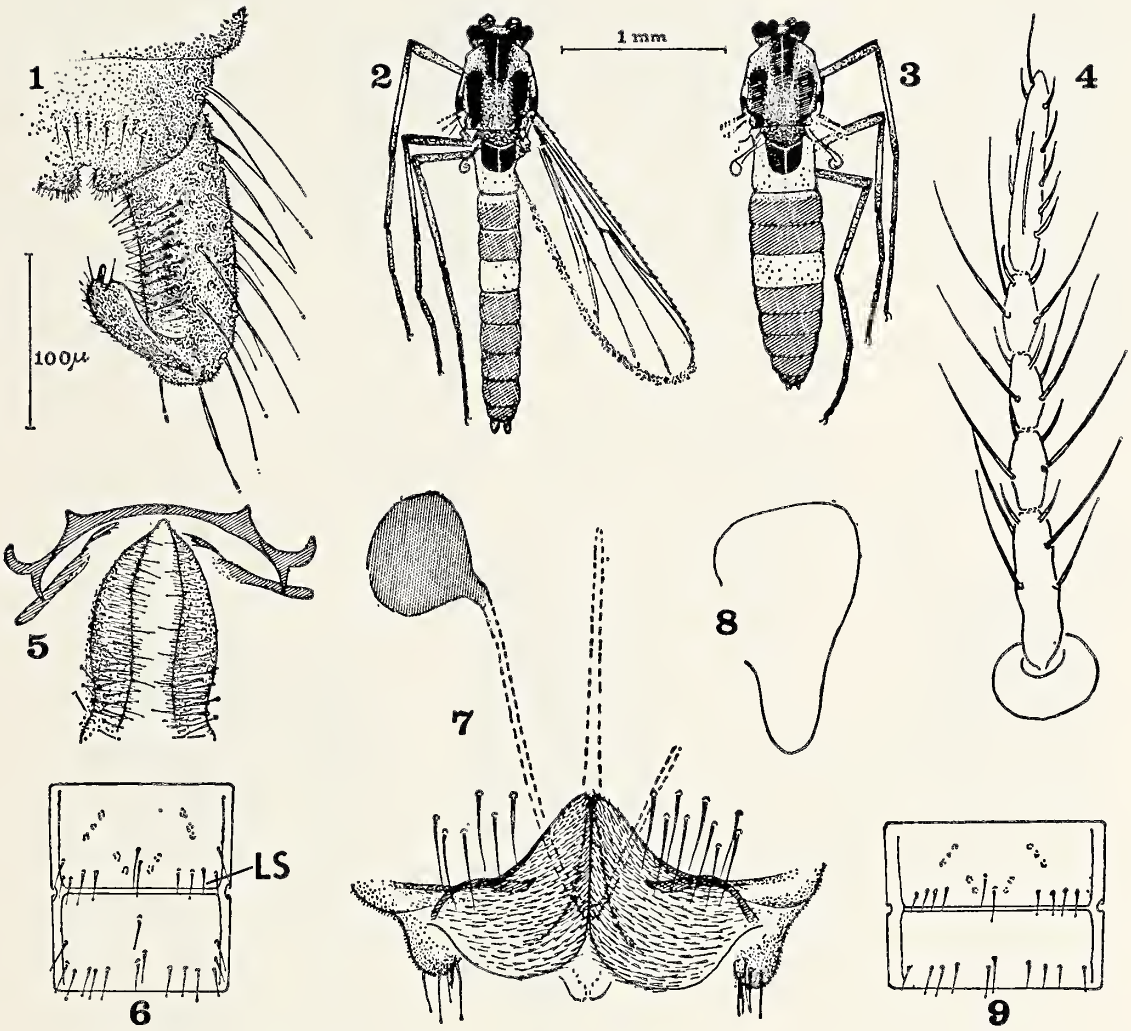


Figure 151. *Cricotopus (C.) similis* Goetgh., adult. Hypopygium of ♂ (1); ♂ (2); ♀ (3); antenna of ♀ (4); aedeagal lobe and phallapodeme of hypopygium (5); chaetotaxy scheme for abdominal tergites III and IV of ♂ (6); spermatheca and outer genitalia of ♀ (7); cercus of ♀ (8); chaetotaxy of abdominal tergites III and IV of ♀ (9). Scale of drawings 1=4, 5, 7, 8; 2=3.—LS lateral setae.

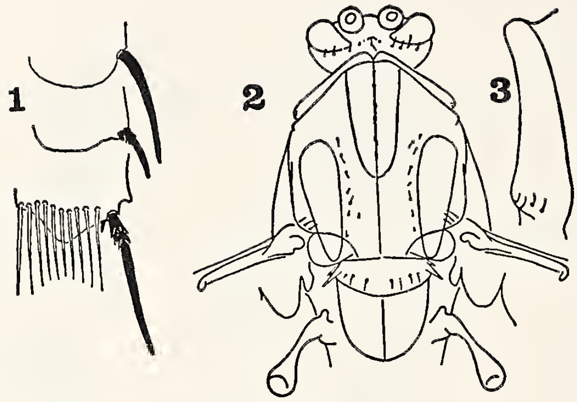


Figure 152. *Cricotopus (C.) caducus* Hirv., adult. Tibial spurs of P_1, P_2 and with tibial comb of P_3 (1): chaetotaxy scheme for head and thorax, dorsal (2); antepronotum, lateral (3).

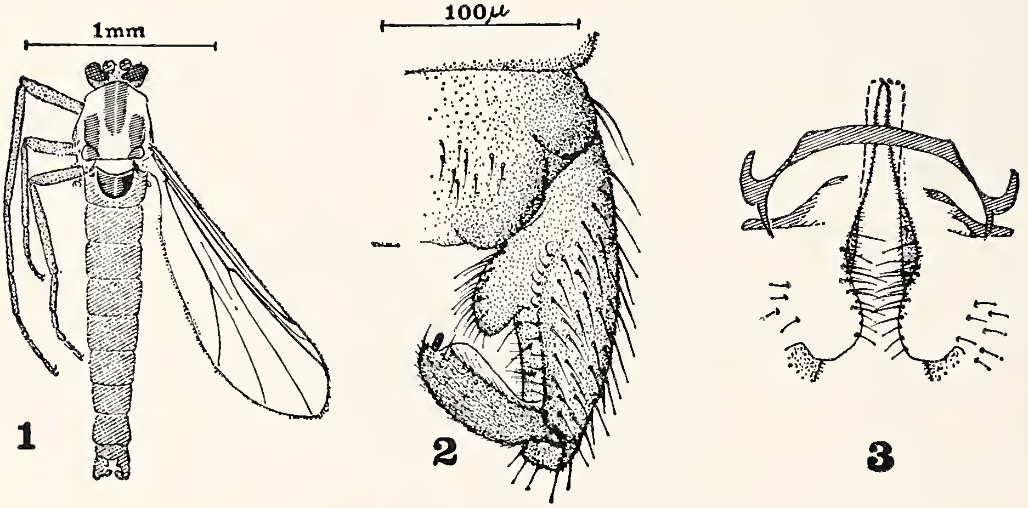


Figure 153. *Cricotopus (C.) guttatus* Hirv., adult. ♂ (1); hypopygium (2); aedeagal lobe and phallapodeme of hypopygium (3).

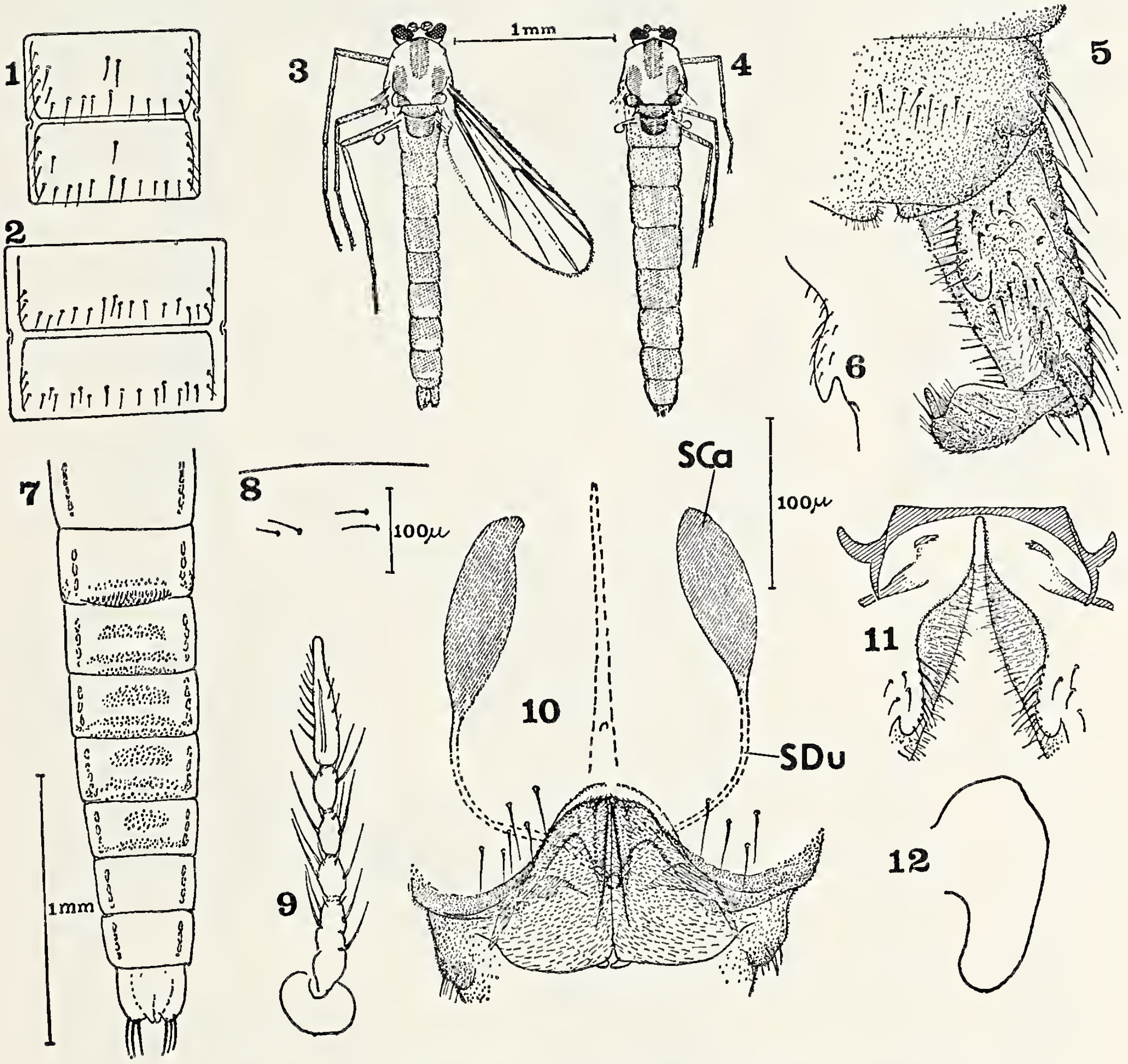


Figure 154. *Cricotopus (C.) caducus* Hirv., adult, pupa. Chaetotaxy scheme for abdominal tergites III and IV of ♂ (1); same of ♀ (2); ♂ (3); ♀ (4); hypopygium of ♂ (5); inferior volsella, more lateral than drawing 5 (6); abdominal segments (pigmentation as in Figure 106) of pupa (7); size relationship and arrangement of Dc setae of pupa (8); antenna of ♀ (9); spermathecae and outer genitalia of ♀ (10); aedeagal lobe and phallapodeme of hypopygium of ♂ (11); cercus of ♀ (12). Scale of drawings 3=4; 5=6, 9−12. — SCa seminal capsule, SDu spermathecal duct.

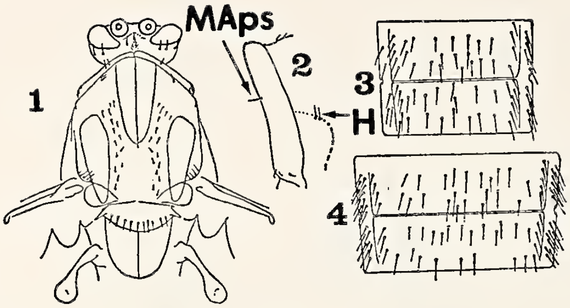


Figure 155. *Cricotopus (Isocladius) dobrogicus* Albu, adult. Chaetotaxy scheme for head and thorax, dorsal (1); antepronotum, lateral (2); chaetotaxy for abdominal tergites III and IV of ♂ (3); same of ♀ (4).—H humeral setae, MAps median setae of antepronotum.

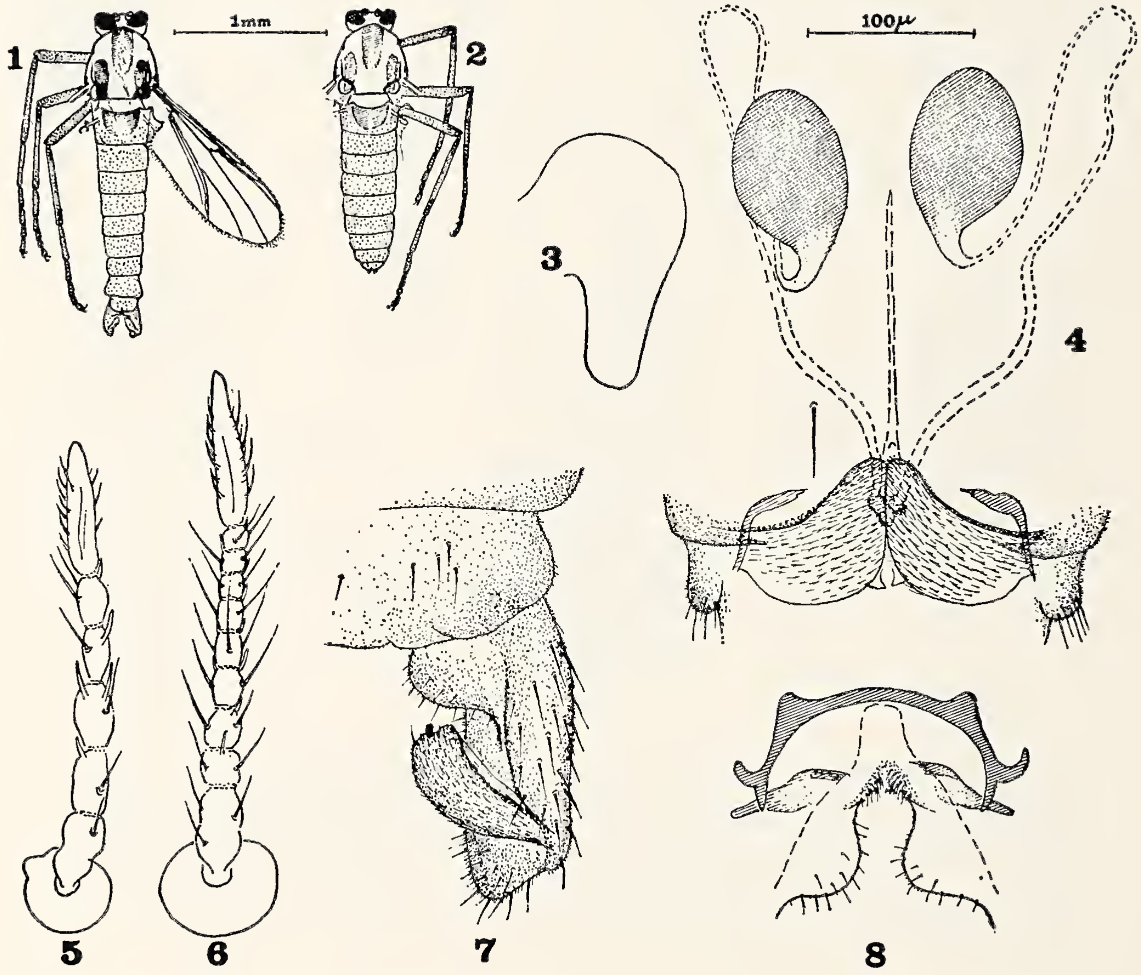


Figure 156. *Cricotopus (Isocladius) dobrogicus* Albu, adult. ♂ (1); ♀ (2); cercus of ♀ (3); spermathecae and outer genitalia of ♀ (4); antenna of ♀ (5); same of ♂ (6); hypopygium (7); aedeagal lobe and phallapodeme of hypopygium (8). Scale of drawings 1=2; 3=4–8.

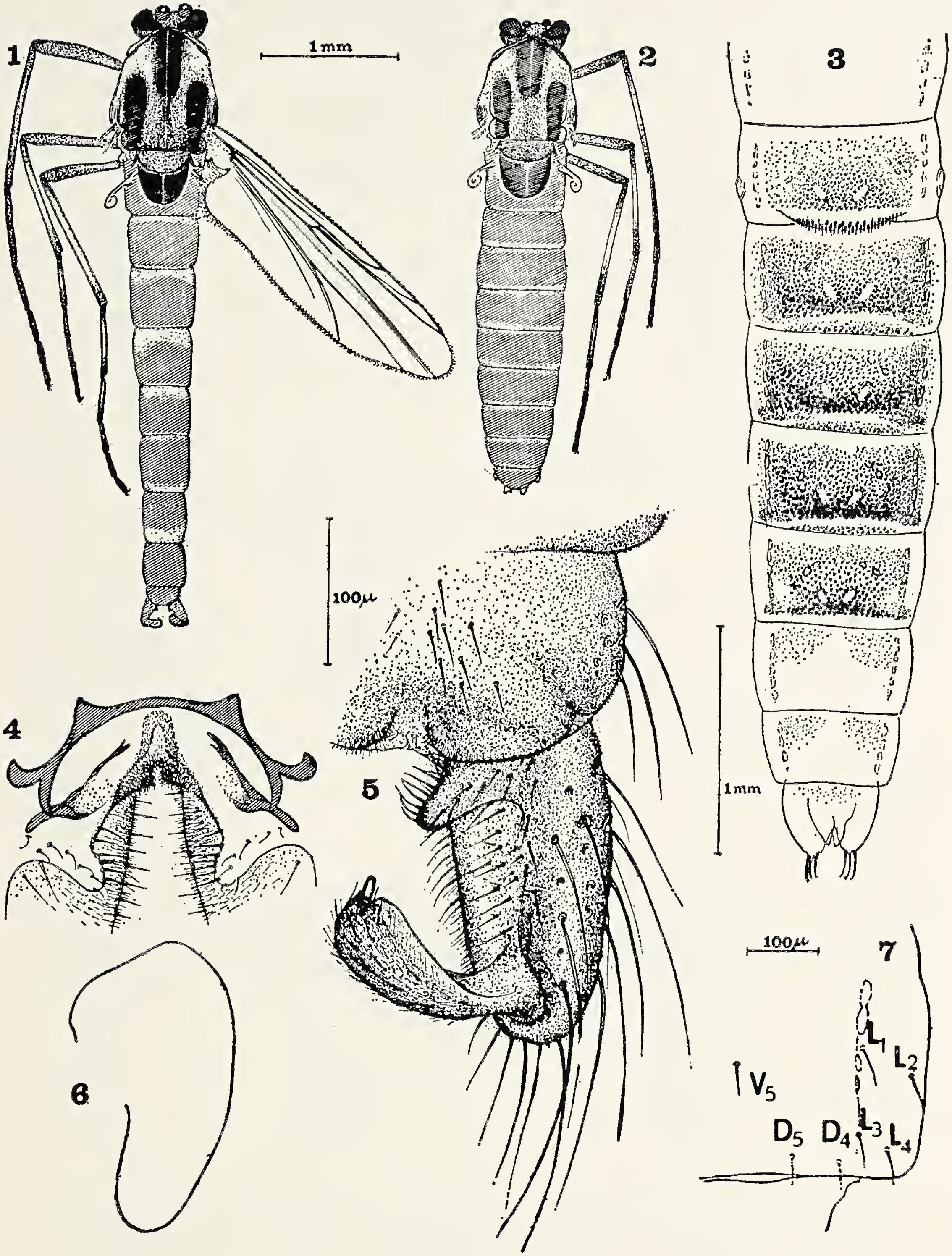


Figure 157. *Cricotopus (Isocladius) ornatus* (Meig.), adult, pupa. ♂ (1); ♀ (2); abdominal segments of pupa (3); aedeagal lobe and phallapodeme of hypopygium (4); hypopygium (5); cercus of ♀ (6); setae (left half) of segment VIII of pupa (7). Scale of drawings 1=2; 4=5–6. D_{4-5} D setae, L_{1-4} lateral setae, V_5 ventral seta 5.

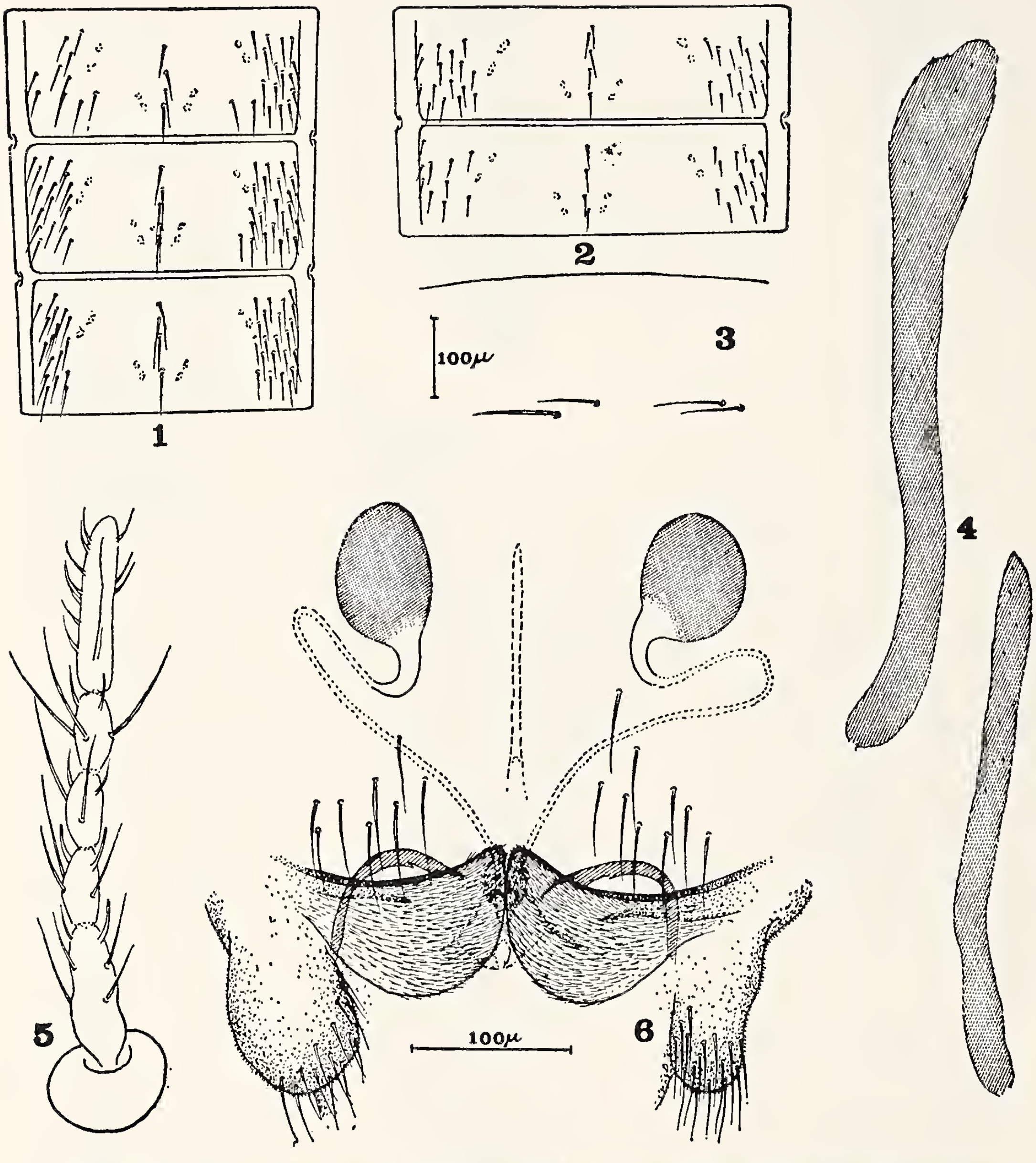


Figure 158. *Cricotopus (Isocladius) ornatus* (Meig.), adult, pupa. Chaetotaxy scheme for abdominal tergites II–IV of ♂ (1); same for III–IV of ♀ (2); size relationship and arrangement of Dc setae of pupa (3); thoracic horn of pupa (4); antenna of ♀ (5); spermathecae and outer genitalia of ♀ (6). Scale of drawings 4=5–6.

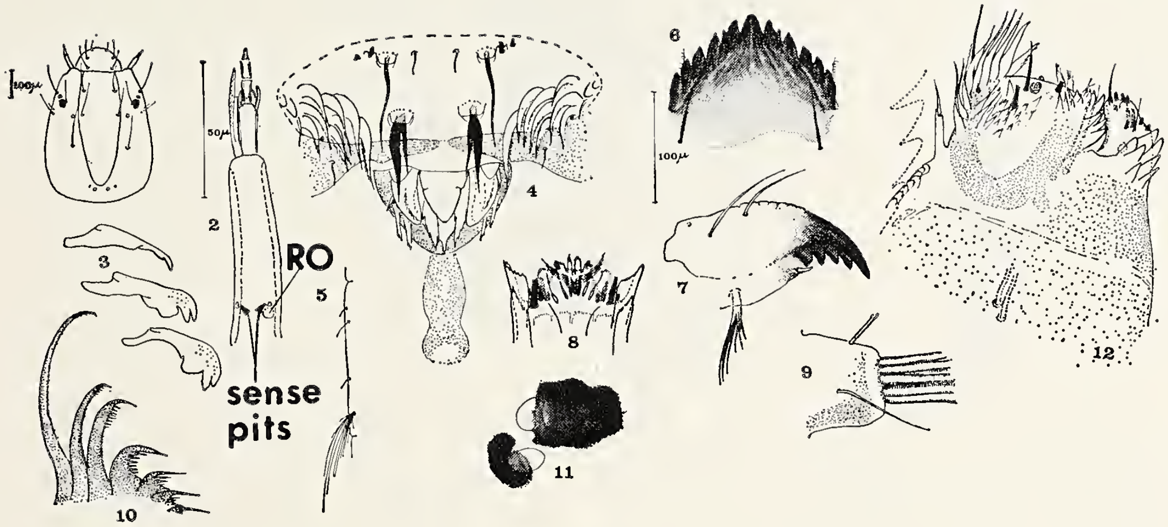


Figure 159. *Cricotopus (Isocladius) ornatus* (Meig.), larva. Head, dorsal (1); antenna (2); variation in premandible caused by different views (3); palatal surface of labrum (4); L setae of abdominal segment IV (5); mentum (6); mandible (7); prementum (8); procercus (9); claws of anterior parapods (10); eyespots (11); maxilla (12). Scale of drawings 1=5; 2=4, 8–12; 3=6–7.—RO ring organ.

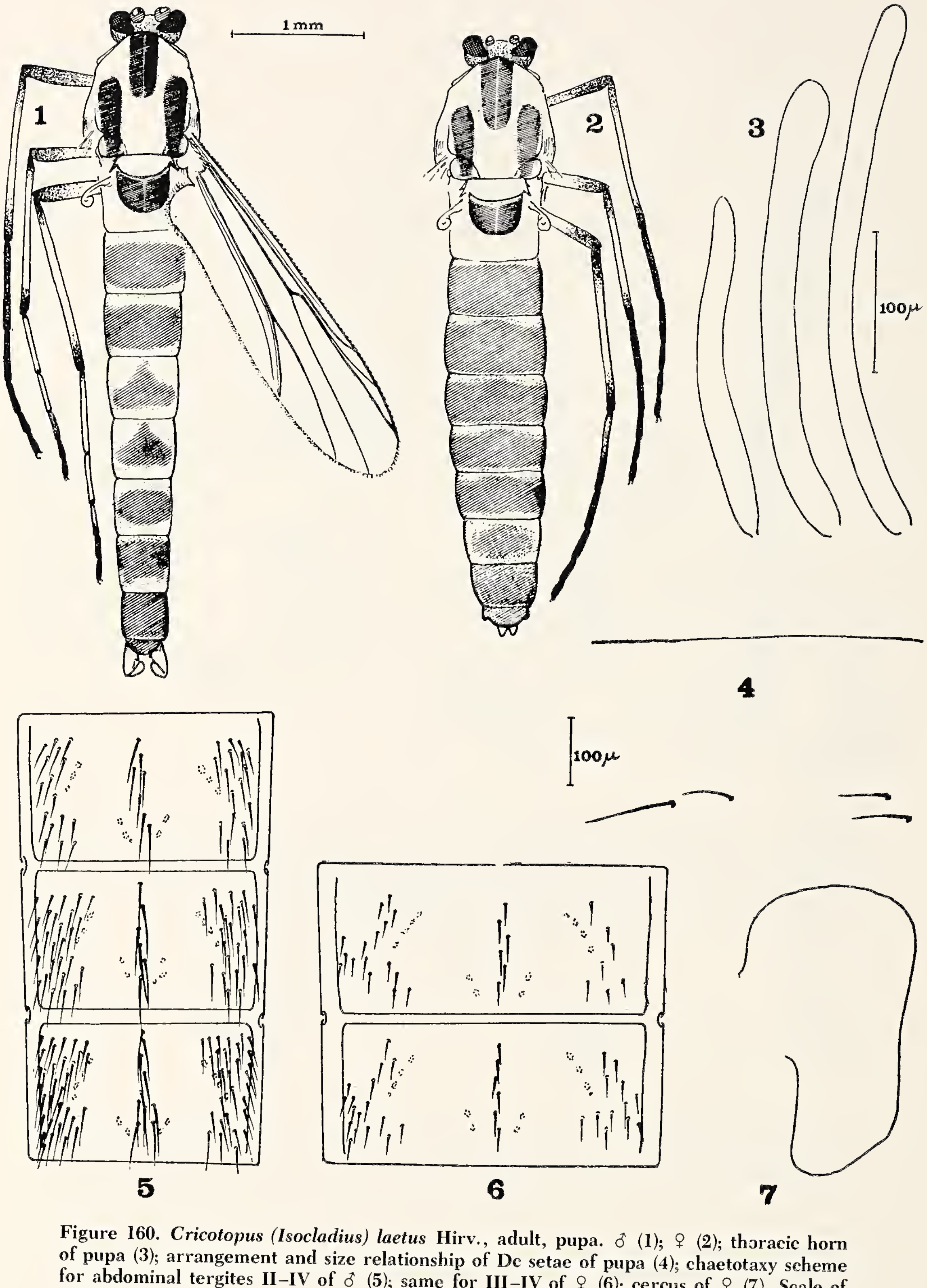


Figure 160. *Cricotopus (Isocladius) laetus* Hirv., adult, pupa. ♂ (1); ♀ (2); thoracic horn of pupa (3); arrangement and size relationship of Dc setae of pupa (4); chaetotaxy scheme for abdominal tergites II–IV of ♂ (5); same for III–IV of ♀ (6); cercus of ♀ (7). Scale of drawings 1=2; 3=7.

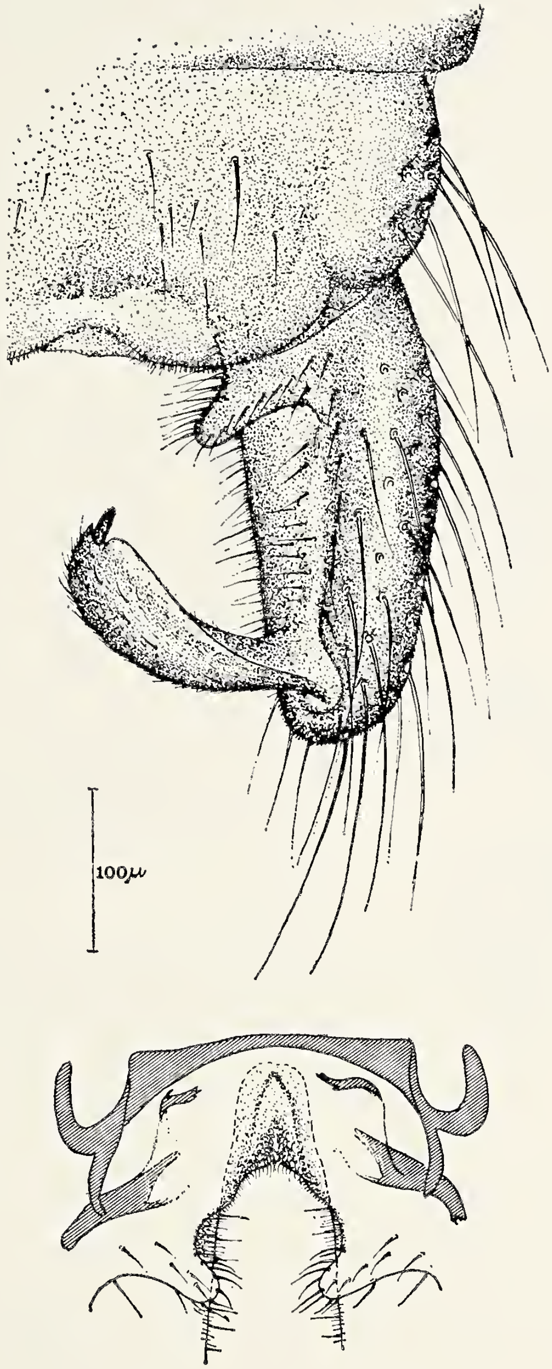
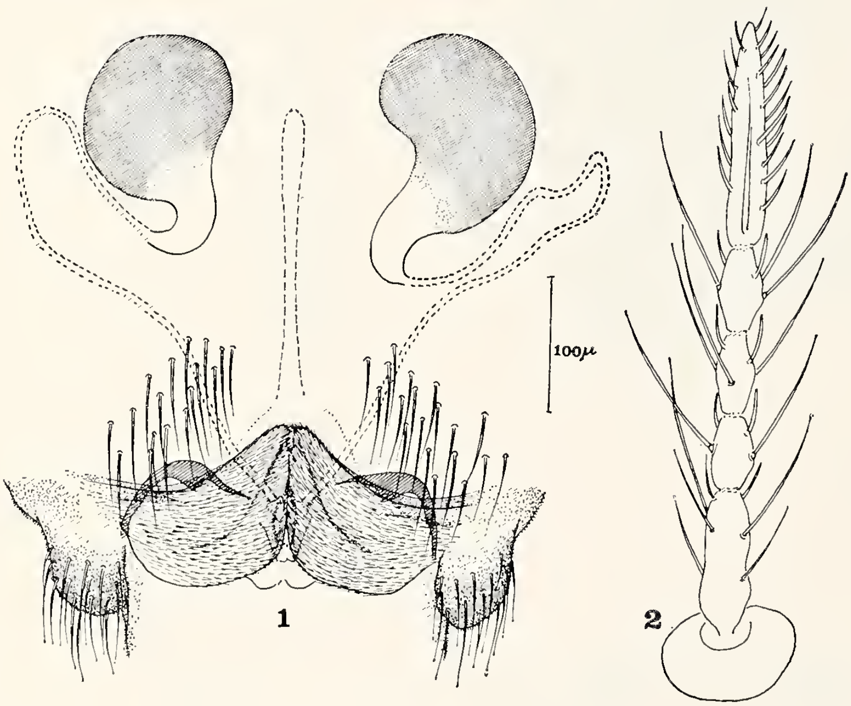


Figure 161. *Cricotopus (Isocladius) laetus* Hirv., hypopygium and (below) aedeagal lobe and phallapodeme of hypopygium of ♂.

Figure 162. *Cricotopus (Isocladius) laetus* Hirv., spermathecae and outer genitalia of ♀ (1); antenna of ♀ (2).



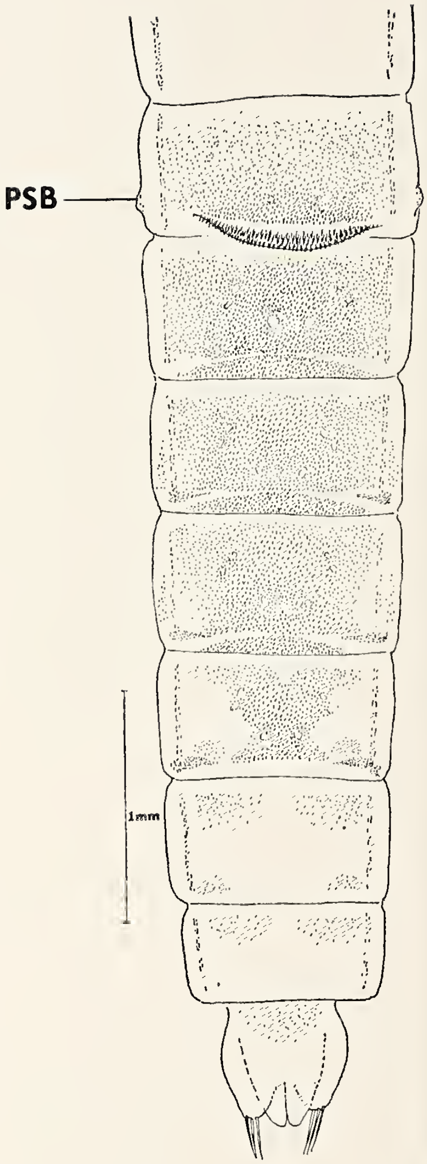


Figure 163. *Cricotopus (Isocladius) laetus* Hirv., shagreen of abdominal segments of pupa.—PSB pedes spurii B.

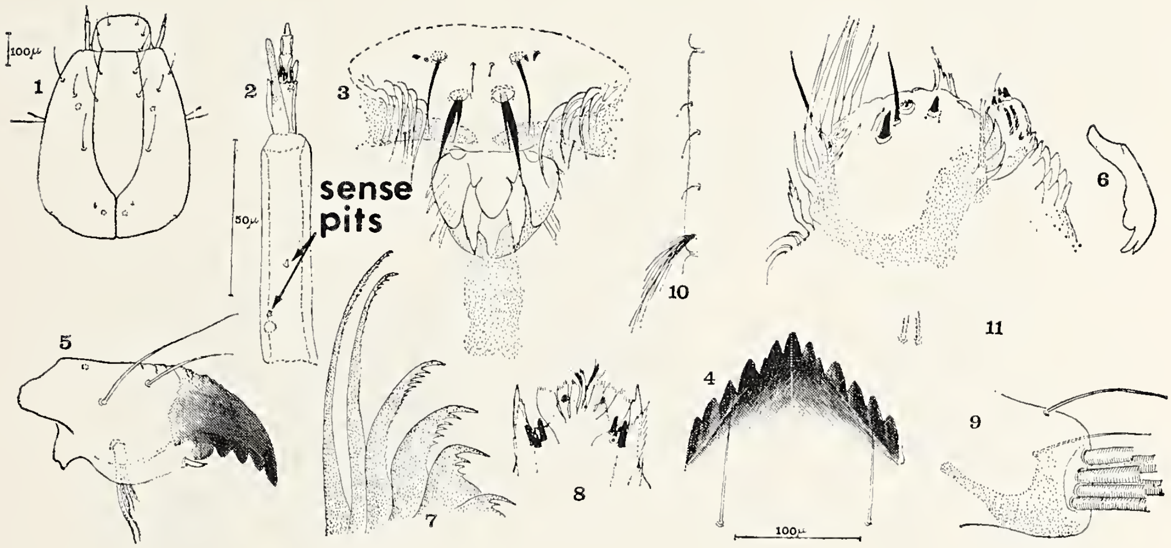


Figure 164. *Cricotopus (Isocladius) laetus* Hirv., larva. Head, dorsal (1); antenna (2); palatal surface of labrum (3); mentum (4); mandible (5); premandible (6); claws of anterior parapods (7); prementum (8); procercus (9); L setae of abdominal segment IV (10); maxilla (11). Scale of drawings 1=10; 2=3, 7−9, 11; 4=5−6.

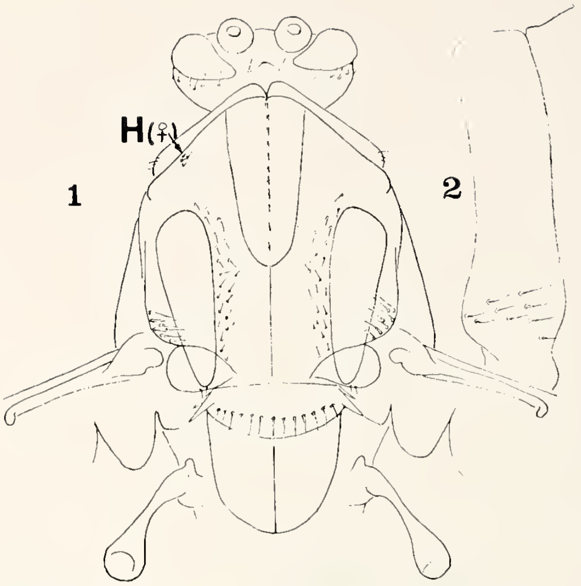


Figure 165. *Cricotopus (Isocladius) pilitarsis* (Zett.), adult. Chaetotaxy scheme for head and thorax, dorsal (1); same for antepronotum, lateral (2).—H humeral setae.

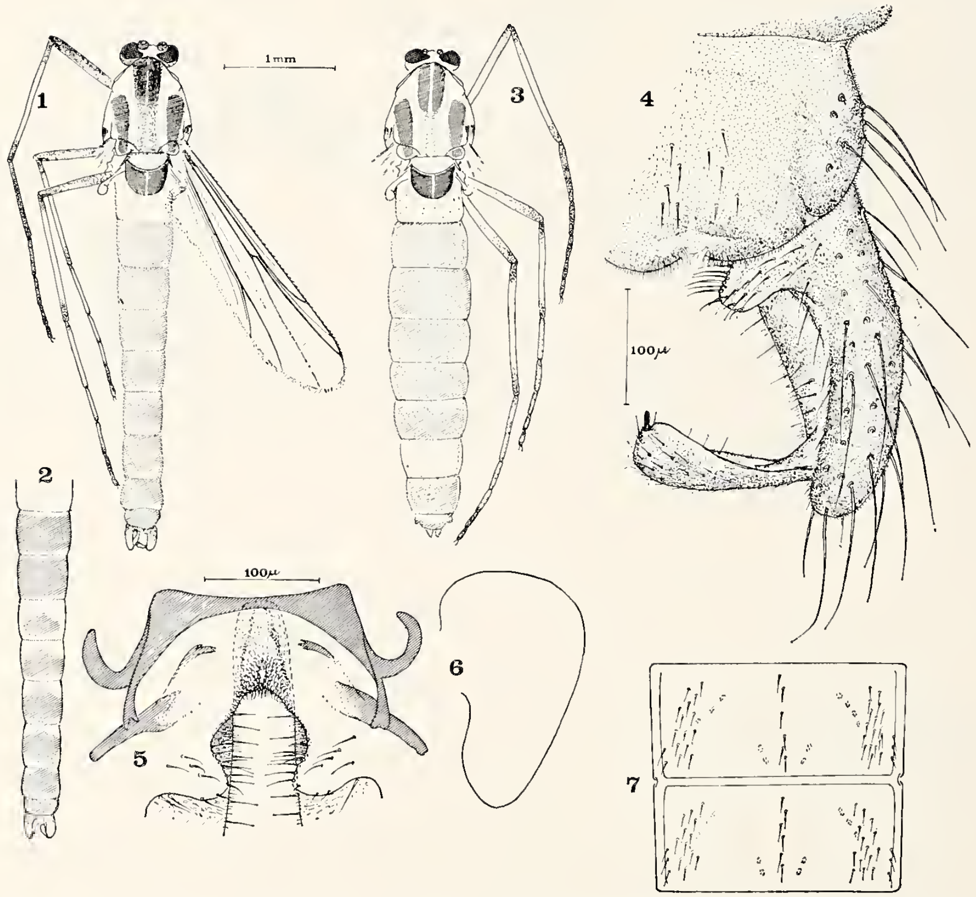


Figure 166. *Cricotopus (Isocladius) pilitarsis* (Zett.), adult. ♂ (1); pigmentation of abdominal tergites of some middle European, light specimens (2); ♀ (3); hypopygium (4); aedeagal lobe and phallapodeme of hypopygium (5); cercus of ♀ (6); chaetotaxy scheme for abdominal tergites III and IV of ♀ (7). Scale of drawings 1=2–3; 4=5–6.

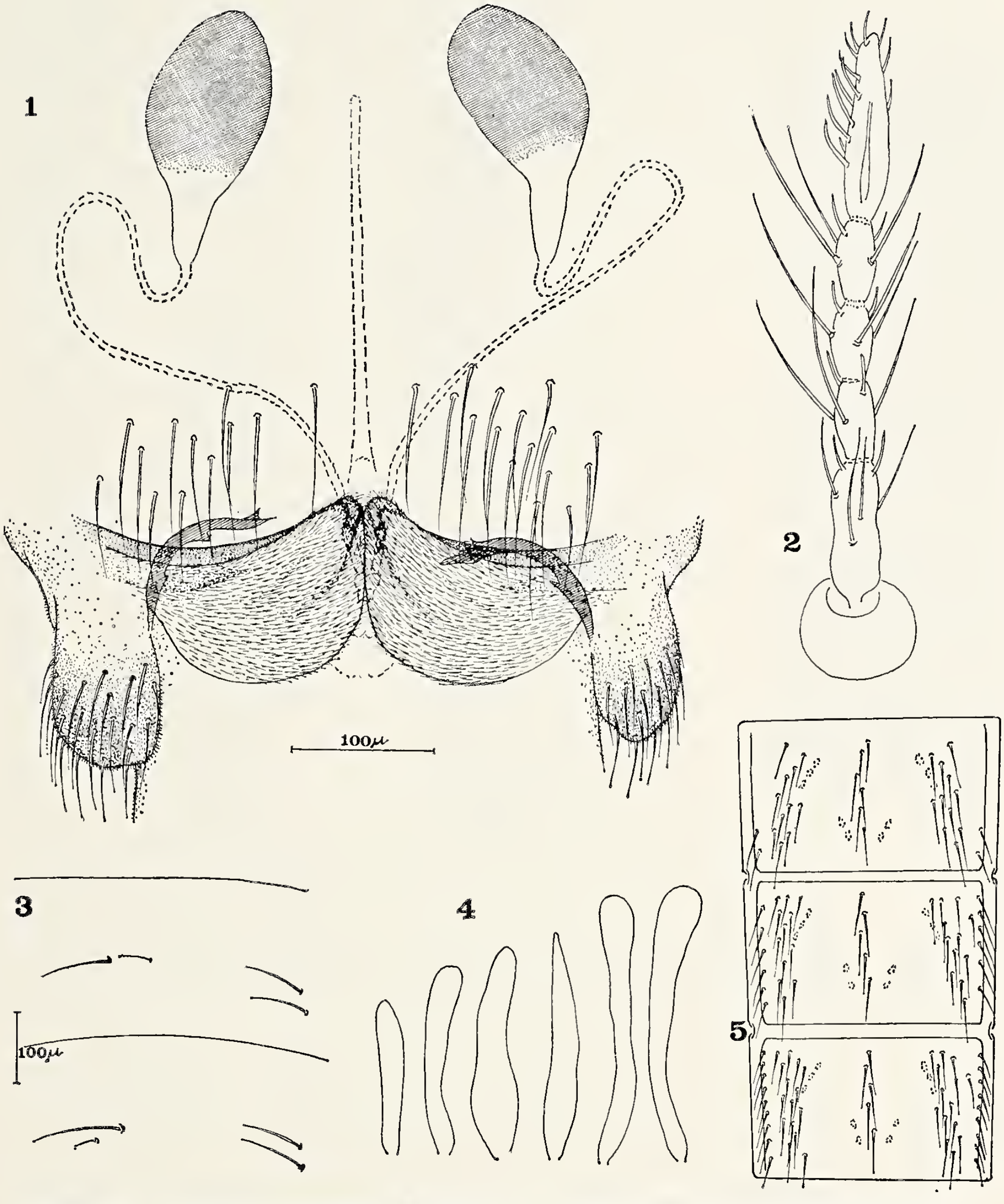


Figure 167. *Cricotopus (Isocladius) pilitarsis* (Zett.), adult, pupa. Spermathecae and outer genitalia of ♀ (1); antenna of ♀ (2); variation in arrangement and size relationship of Dc setae of pupa (3); thoracic horn of pupa (4); chaetotaxy scheme for abdominal tergites II–IV of ♂ (5). Scale of drawings 1=2, 4.

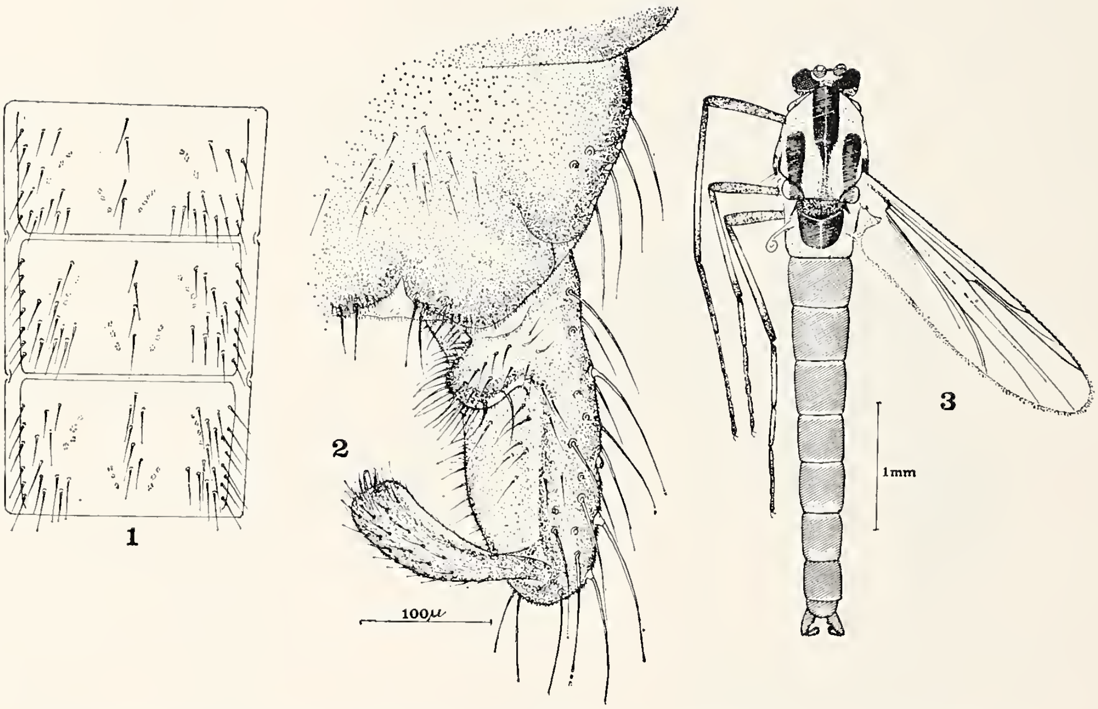


Figure 168. *Cricotopus (Isocladius) pilicauda* Hirv., ♂. Chaetotaxy scheme of abdominal tergites II–IV(1); hypopygium (2); ♂ (3).

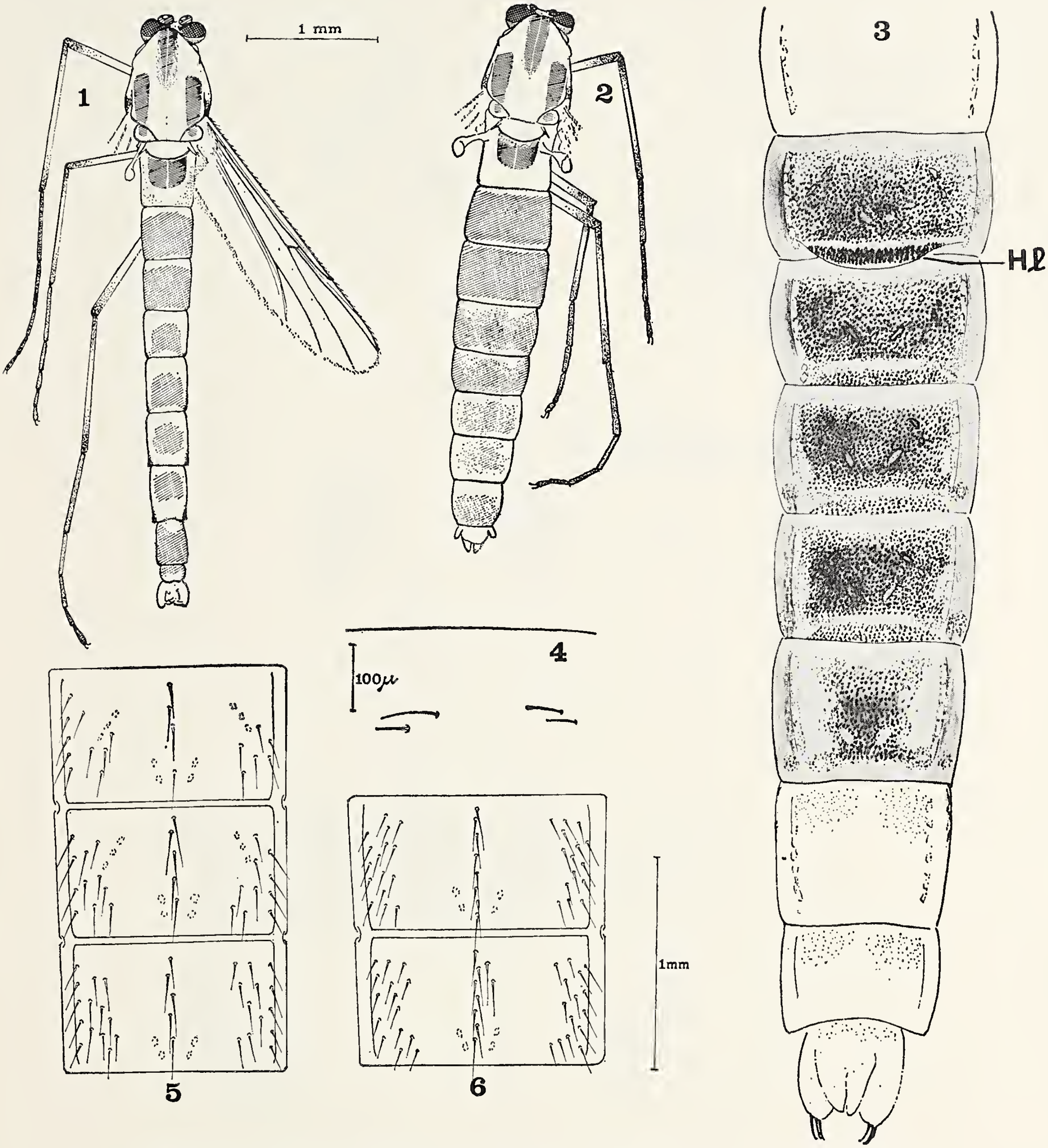


Figure 169. *Cricotopus (Isocladius) relucens* Hirv., adult, pupa. ♂ (1); ♀ (2); pigmentation and shagreen of abdominal tergites of pupa (3); size relationship and arrangement of Dc setae of pupa (4); chaetotaxy scheme for abdominal tergites II–IV of ♂ (5); same for III–IV of ♀ (6).—Hl hooklets.

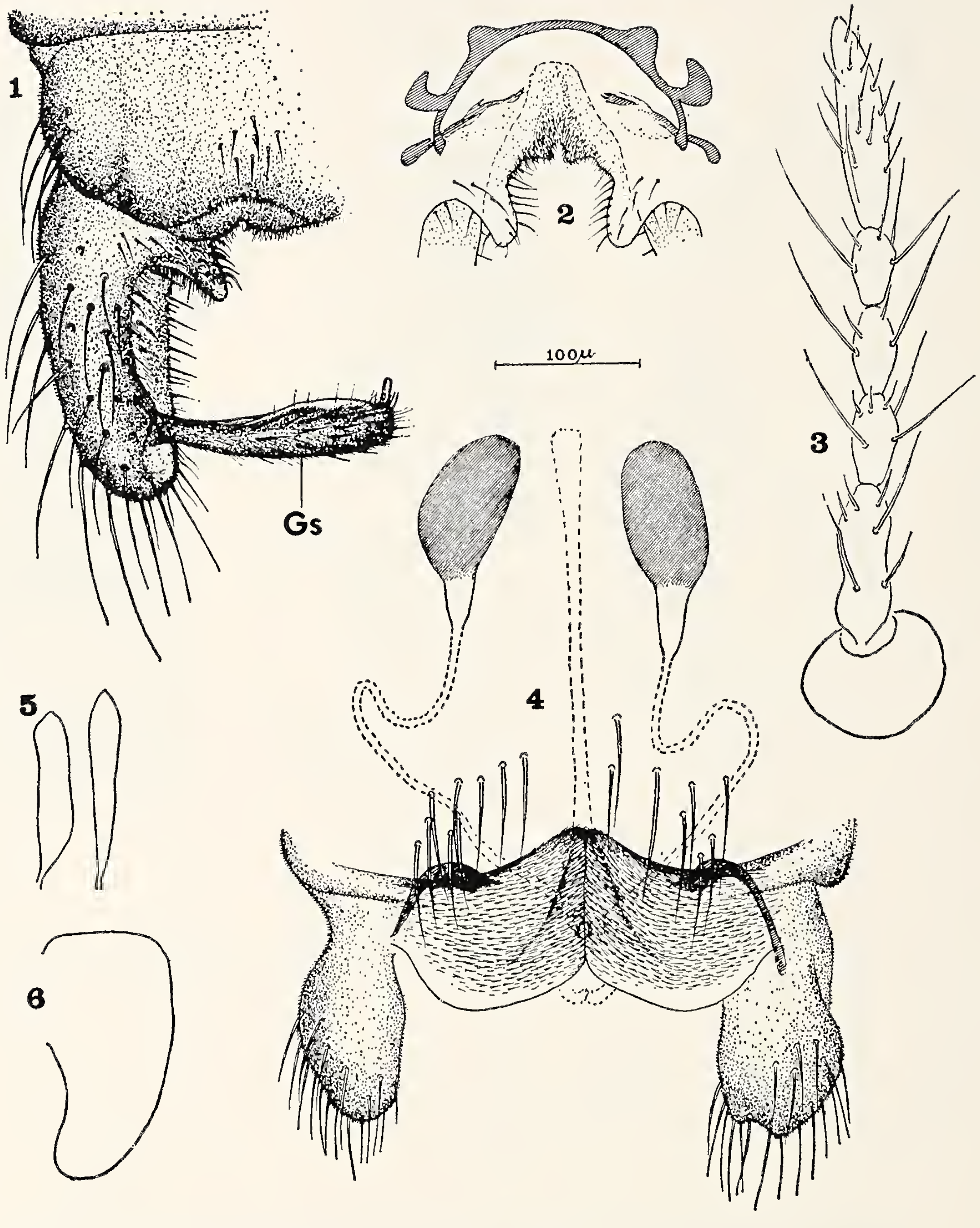


Figure 170. *Cricotopus (Isocladius) relucens* Hirv., adult, pupa. Hypopygium (1); aedeagal lobe and phallapodeme of hypopygium (2); antenna of ♀ (3); spermathecae and outer genitalia of ♀ (4); thoracic horn of pupa (5); cercus of ♀ (6). Scale of drawings 1=2–6.—Gs gonostylus.

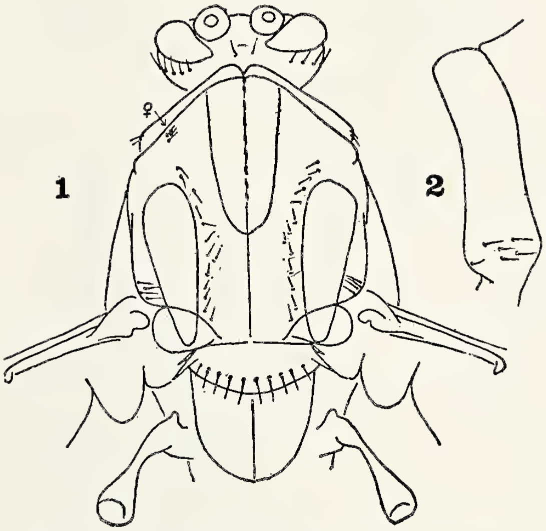


Figure 171. *Cricotopus (Isocladius) sylvestris* (Fabr.), adult. Chaetotaxy scheme for head and thorax, dorsal (1); antepronotum, lateral (2).

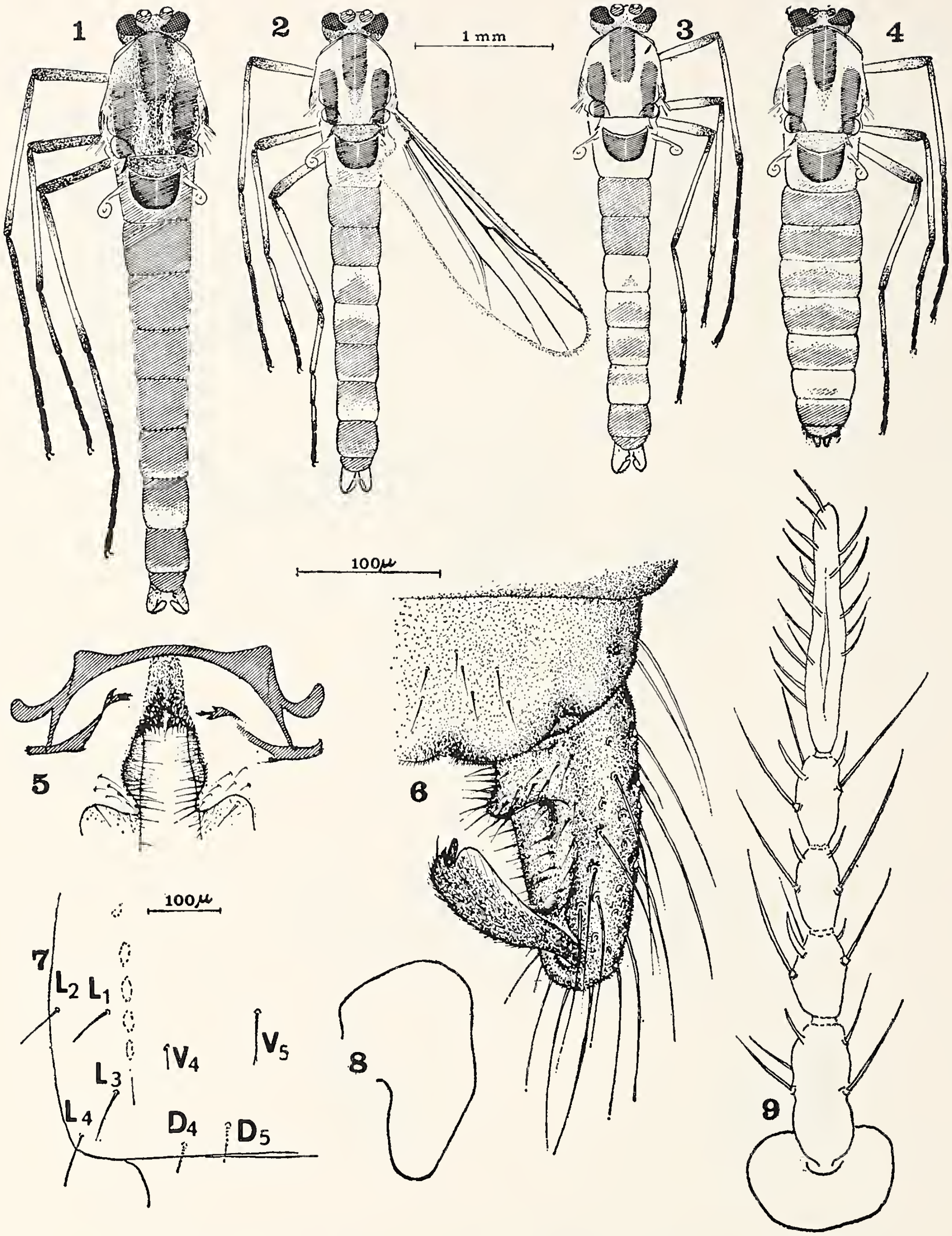


Figure 172. *Cricotopus (Isocladius) sylvestris* (Fabr.), adult and pupa. Large (Sompiojärvi) (1), "normal" (2), and weak (3) pigmentation of ♂ "normal", pigmentation of ♀ (4); aedeagal lobe and phallapodeme of hypopygium (5); hypopygium (6); setae of anal angle of abdominal segment VIII, ventral, of pupa (7); cercus of ♀ (8); antenna of ♀ (9). Scale of drawings 1=2–4; 5=6, 8–9. D_{4-5} D setae, L_{1-4} lateral setae, V_5 ventral seta 5.

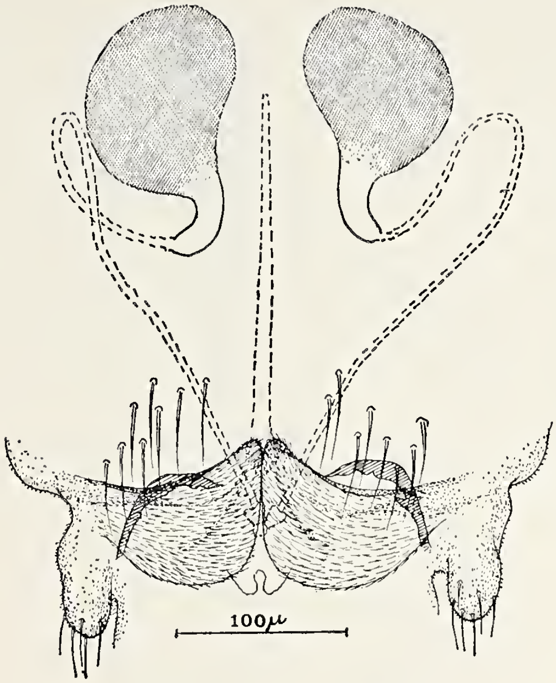


Figure 173. *Cricotopus (Isocladius) sylvestris* (Fabr.), spermathecae and outer genitalia of ♀.

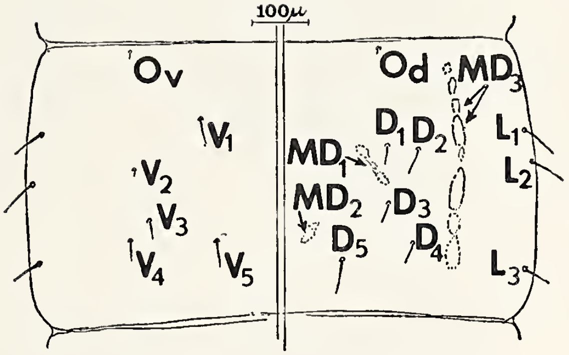


Figure 174. *Cricotopus (Isocladius) sylvestris* (Fabr.), chaetotaxy for abdominal segment IV of pupa. —MD$_{1-3}$ muscle marks, dorsal, O$_d$ dorsal and O$_v$ ventral O setae, V$_{1-5}$ ventral setae, L$_{1-3}$ lateral setae, D$_{1-5}$ dorsal setae.

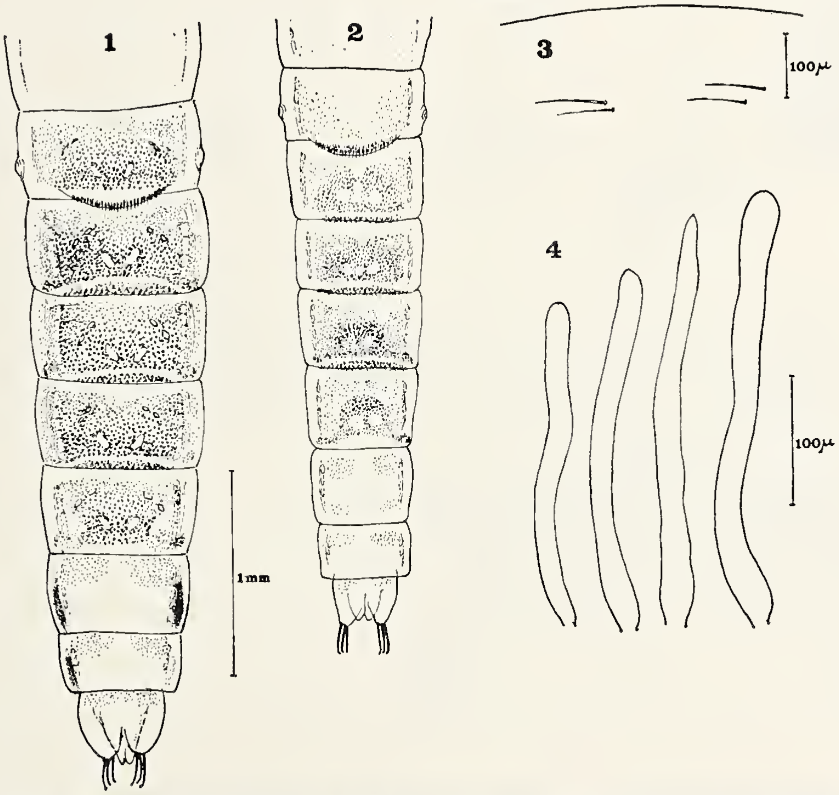


Figure 175. *Cricotopus (Isocladius) sylvestris* (Fabr.), pupa. Abdominal segments from collections in spring (1) and in summer (2) from some small ponds in Riihimäki, Südfinnland; size relationship and arrangement of Dc setae (3); variation in thoracic horn (4).

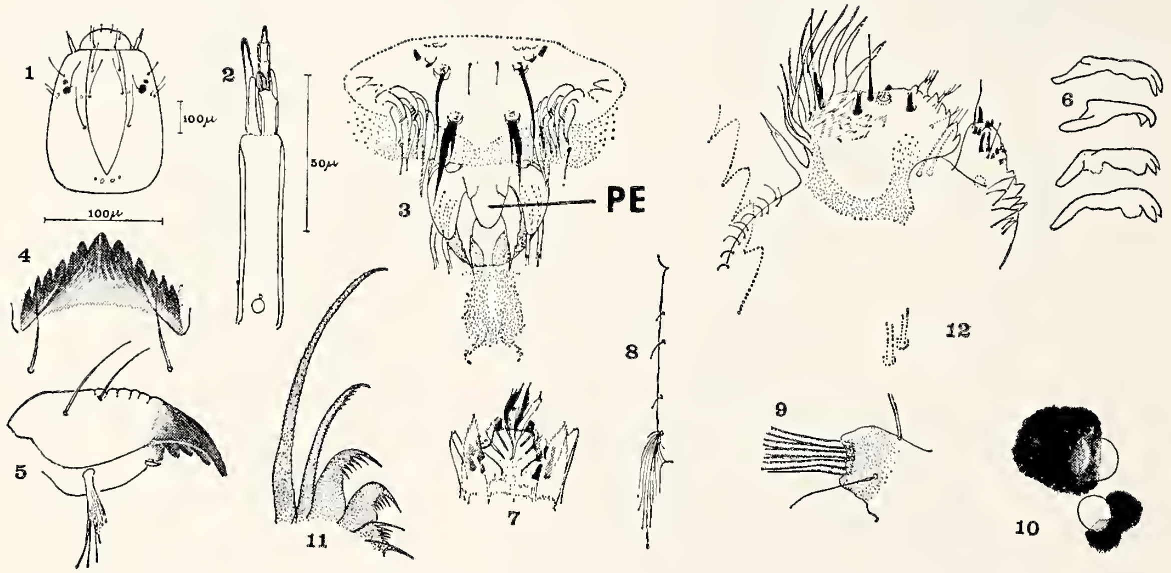


Figure 176. *Cricotopus (Isocladius) sylvestris* (Fabr.),larva. Head, dorsal (1); antenna (2); palatal surface of labrum (3); mentum (4); mandible (5); variation in premandible by different views (6); prementum (7); L setae of abdominal segment IV (8); procercus (9); eyespots (10); claws of anterior parapods (11); maxilla (12). Scale of drawings 1=8; 2=3, 7–12; 4=5–6. PE pecten epipharyngis.

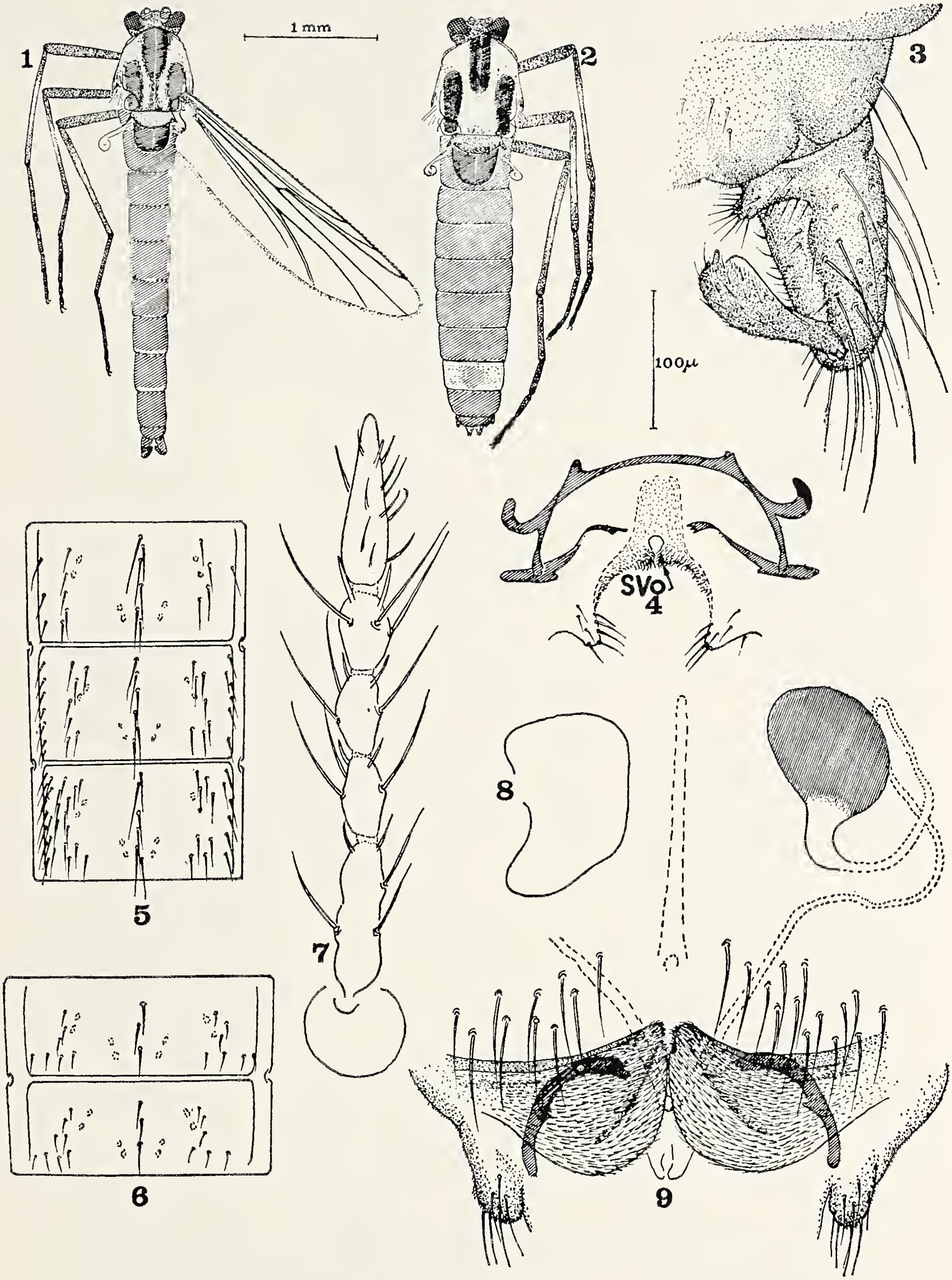


Figure 177. *Cricotopus (Isocladius) glacialis* Edw., adult. ♂ (1); ♀ (2); hypopygium (3); aedeagal lobe and phallapodeme of hypopygium (4); chaetotaxy scheme for abdominal tergites II–IV of ♂ (5); chaetotaxy of tergites III–IV of ♀ (6); antenna (7); cercus of ♀ (8); spermatheca and outer genitalia of ♀ (9). Scale of drawings 1=2; 3=4, 7–9. —SVo superior volsella.

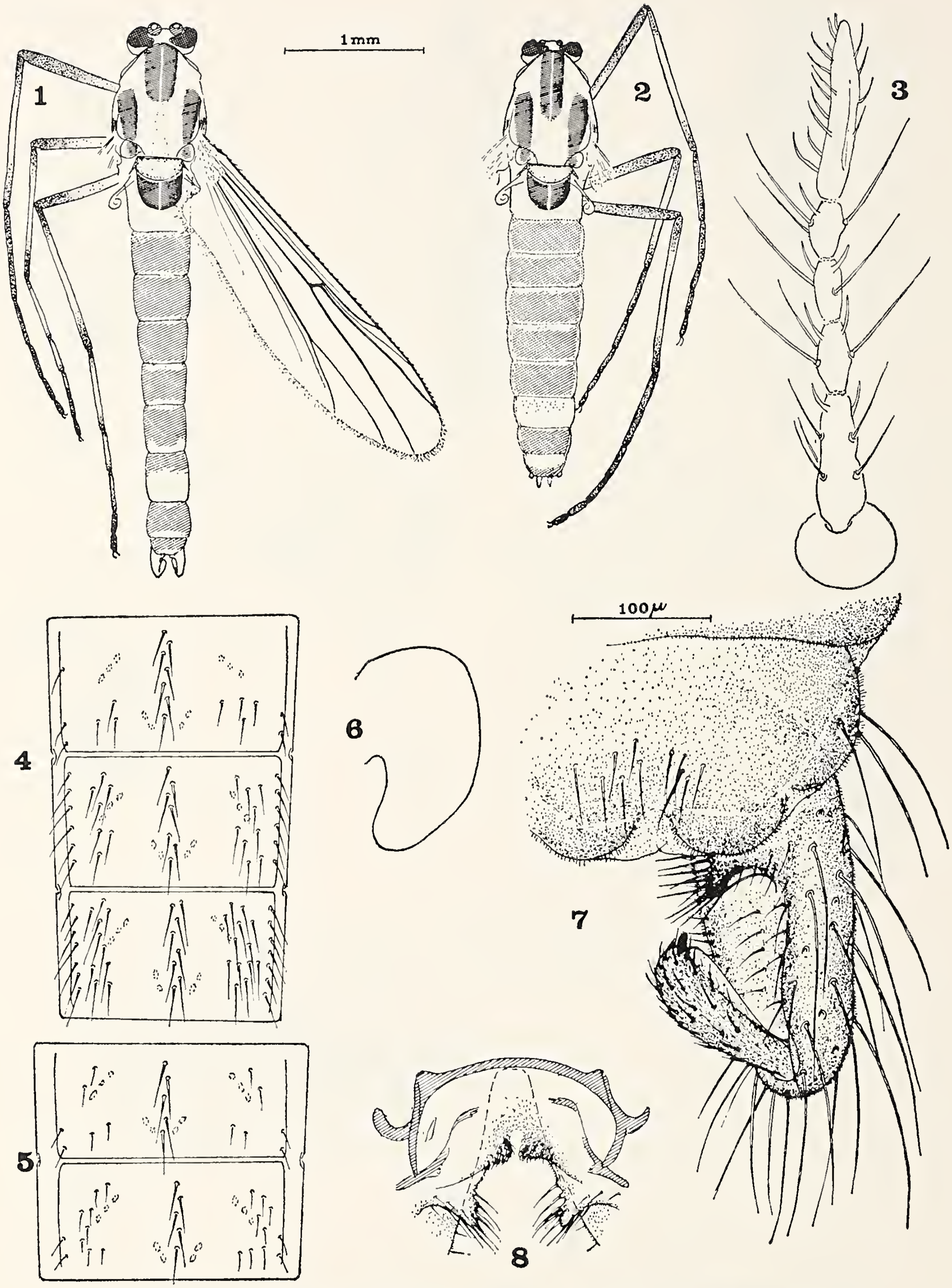


Figure 178. *Cricotopus (Isocladius) suspiciosus* Hirv., adult. ♂ (1); ♀ (2); antenna of ♀ (3); chaetotaxy scheme for abdominal tergites II–IV of ♂ (4); same for III–IV of ♀ (5); cercus of ♀ (6); hypopygium (7); aedeagal lobe and phallapodeme of hypopygium (8). Scale of drawings 1=2; 3=6–8.

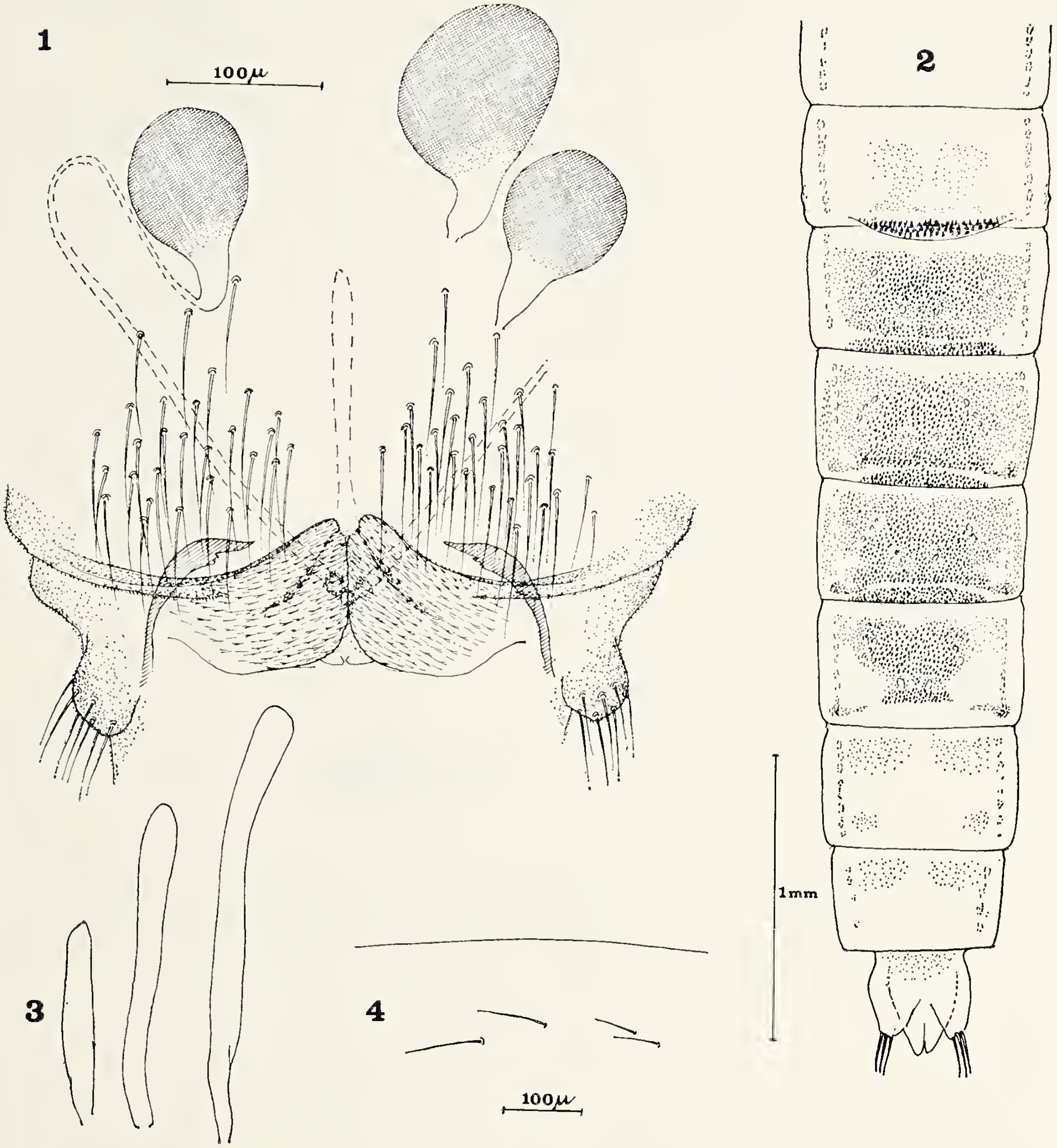


Figure 179. *Cricotopus (Isocladius) suspiciosus* Hirv., adult, pupa. Variation in spermathecae and outer genitalia of ♀ (1); shagreen (pigmentation refer to Figure 169) of abdominal segments (2); variation in thoracic horn (3); size relationship and arrangement of Dc setae of pupa (4). Scale of drawings 1=3.

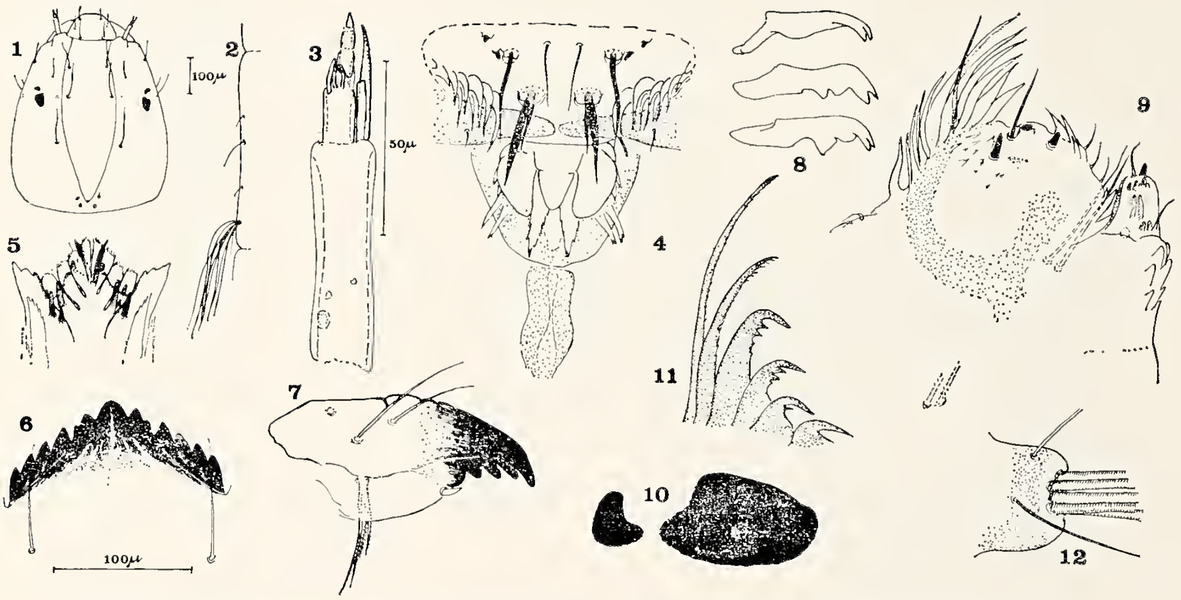


Figure 180. *Cricotopus (Isocladius) suspiciosus* Hirv., larva. Head, dorsal (1); L setae of abdominal segment IV (2); antenna (3): palatal surface of labrum (4); prementum (5); mentum (6); mandible (7); variation in premandible caused by different views (8); maxilla (9); eyespots (10); claws of anterior parapods (11); procercus (12). Scale of drawings 1=2; 3=4–5, 9–12; 6=7–8.

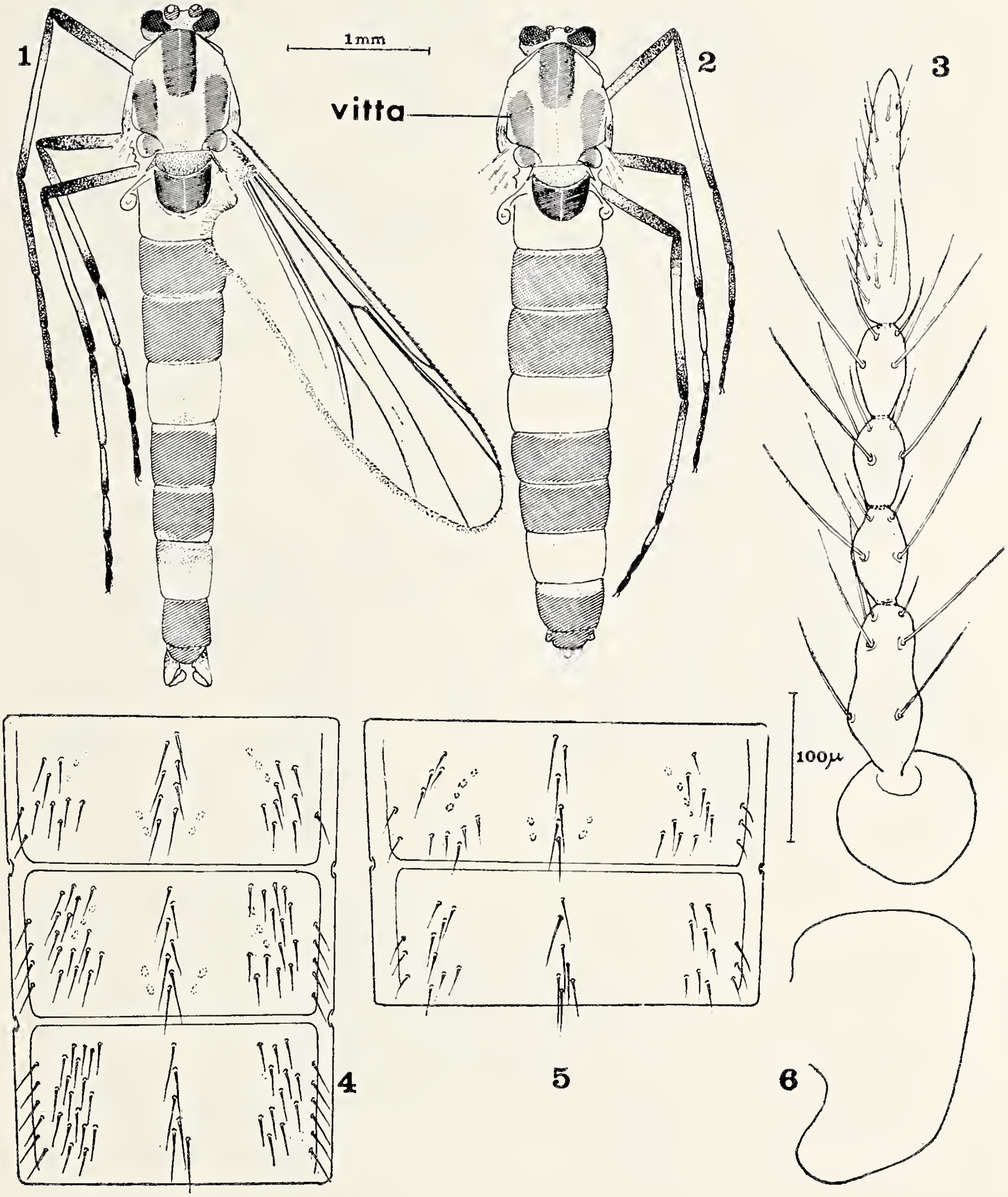


Figure 181. *Cricotopus (Isocladius) trifasciatus* (Meig.), "large form," adult. ♂ (1); ♀ (2); antenna of ♀ (3); chaetotaxy scheme for abdominal tergites II–IV of ♂ (4); same for III–IV of ♀ (5); cercus of ♀ (6). Scale of drawings 1=2; 3=6.

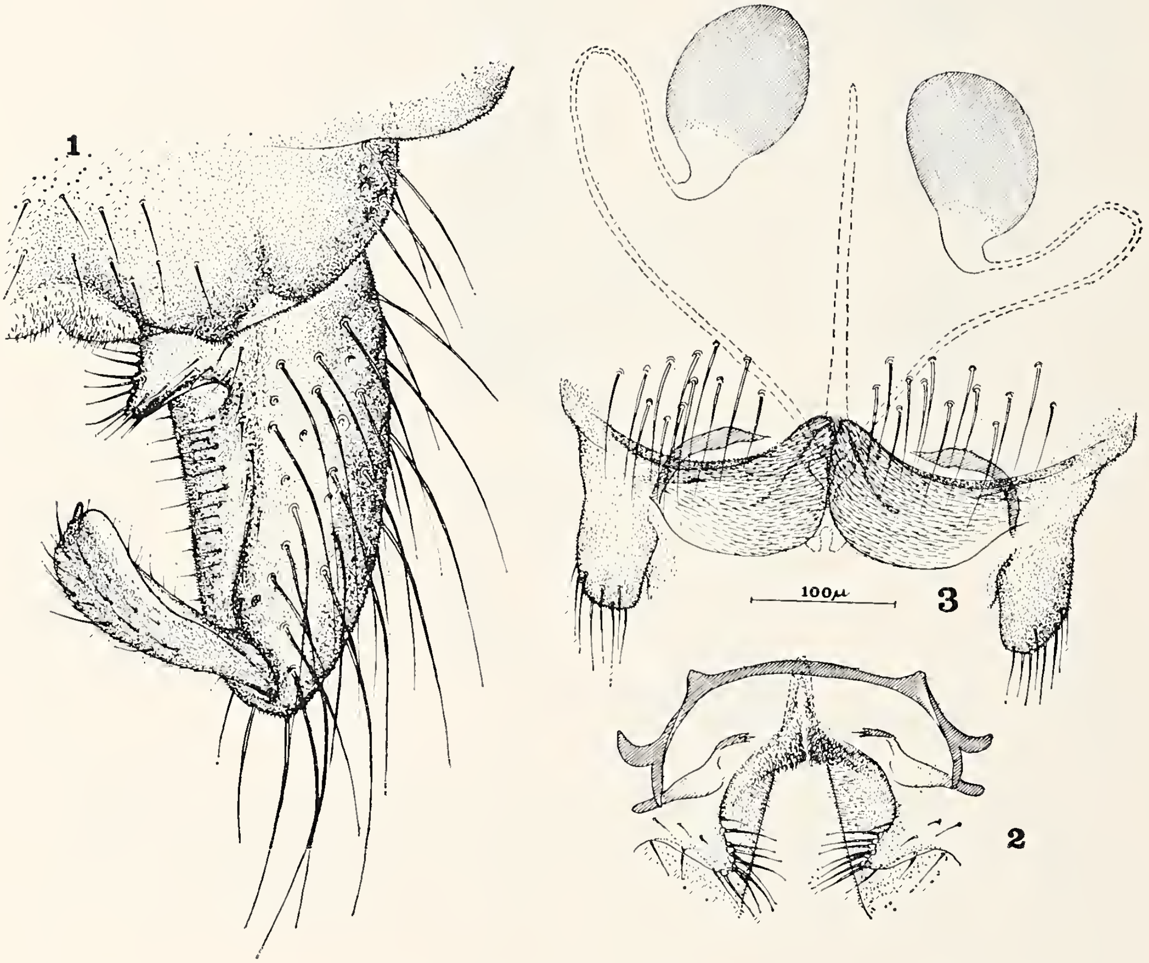


Figure 182. *Cricotopus (Isocladius) trifasciatus* (Meig.), "large form," adult. Hypopygium of ♂ (1); aedeagal lobe and phallapodeme of hypopygium (2); spermathecae and outer genitalia of ♀ (3).

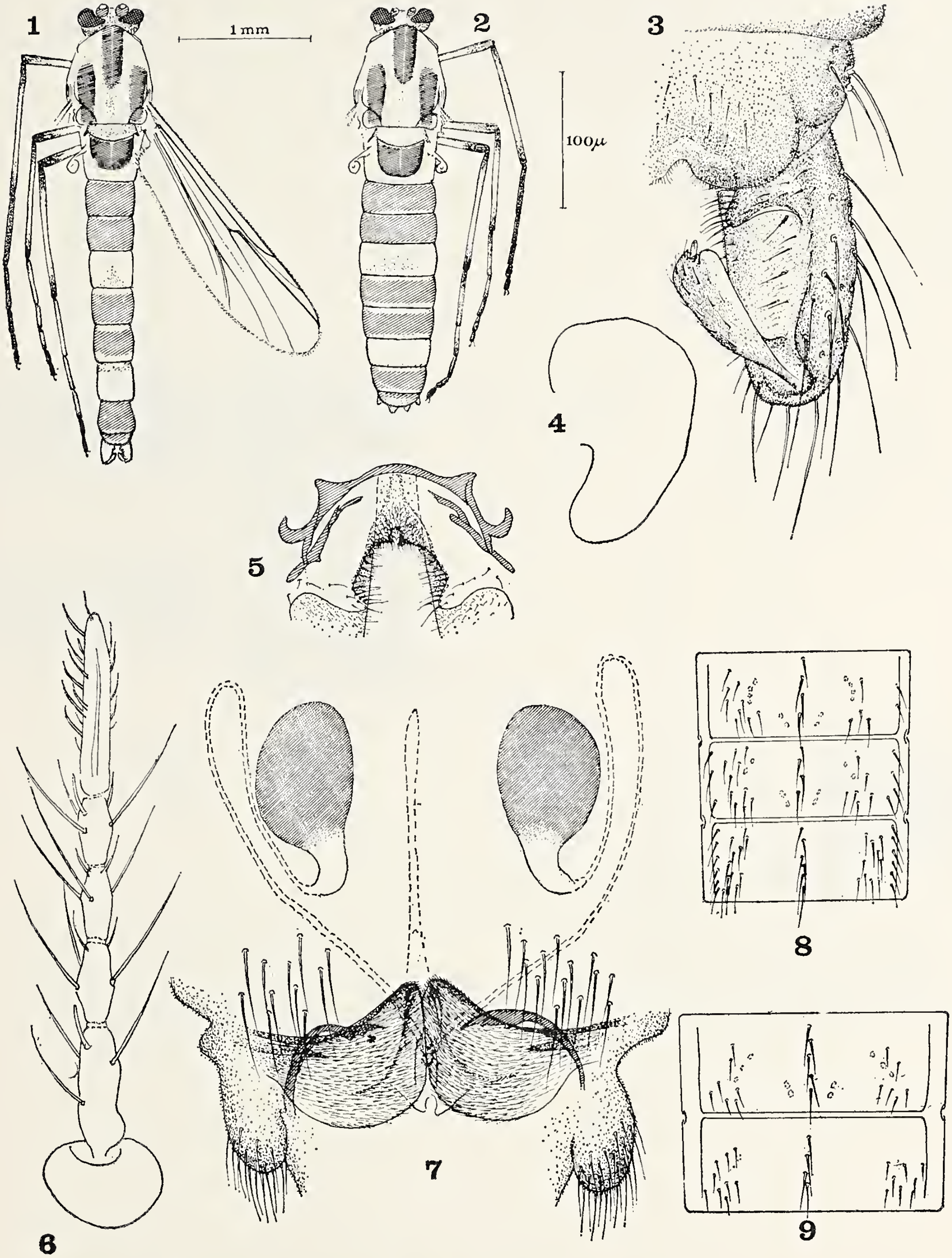


Figure 183. *Cricotopus (Isocladius) trifasciatus* (Meig.), "small form," adult. ♂ (1); ♀ (2); hypopygium of ♂ (3); cercus of ♀ (4); aedeagal lobe and phallapodeme of hypopygium (5); antenna of ♀ (6): spermathecae and outer genitalia of ♀ (7); chaetotaxy scheme for abdominal tergites II–IV of ♂ (8); same for III–IV of ♀ (9). Scale of drawings 1=2; 3=4–7.

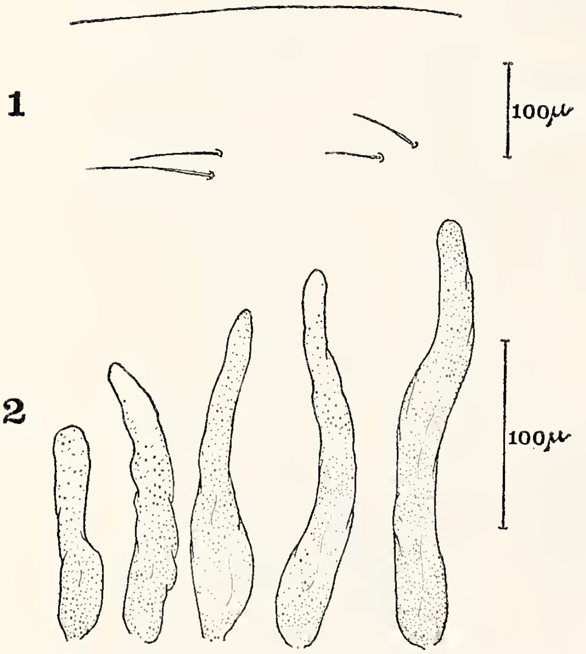


Figure 184. *Cricotopus (Isocladius) trifasciatus* (Meig.), "small form," pupa. Size relationship and arrangement of Dc setae (1); variation in thoracic horn. (2).

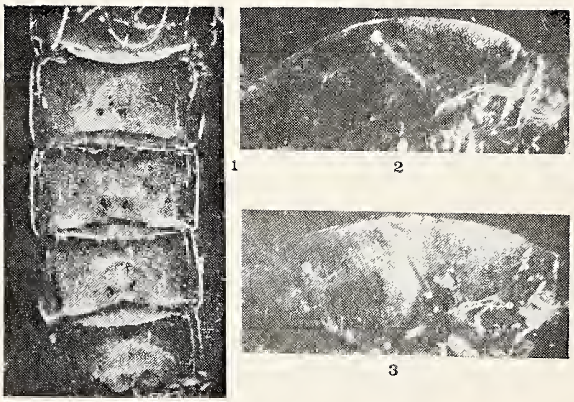


Figure 185. Shagreen of abdominal tergites (1) of *Cricotopus (Isocladius) trifasciatus* (Meig.), "small form," suture margin (thoracic region) of the same species (3) and (2) of *C.* (*I.*) *tricinctus* (Meig.). (Dark field photography).

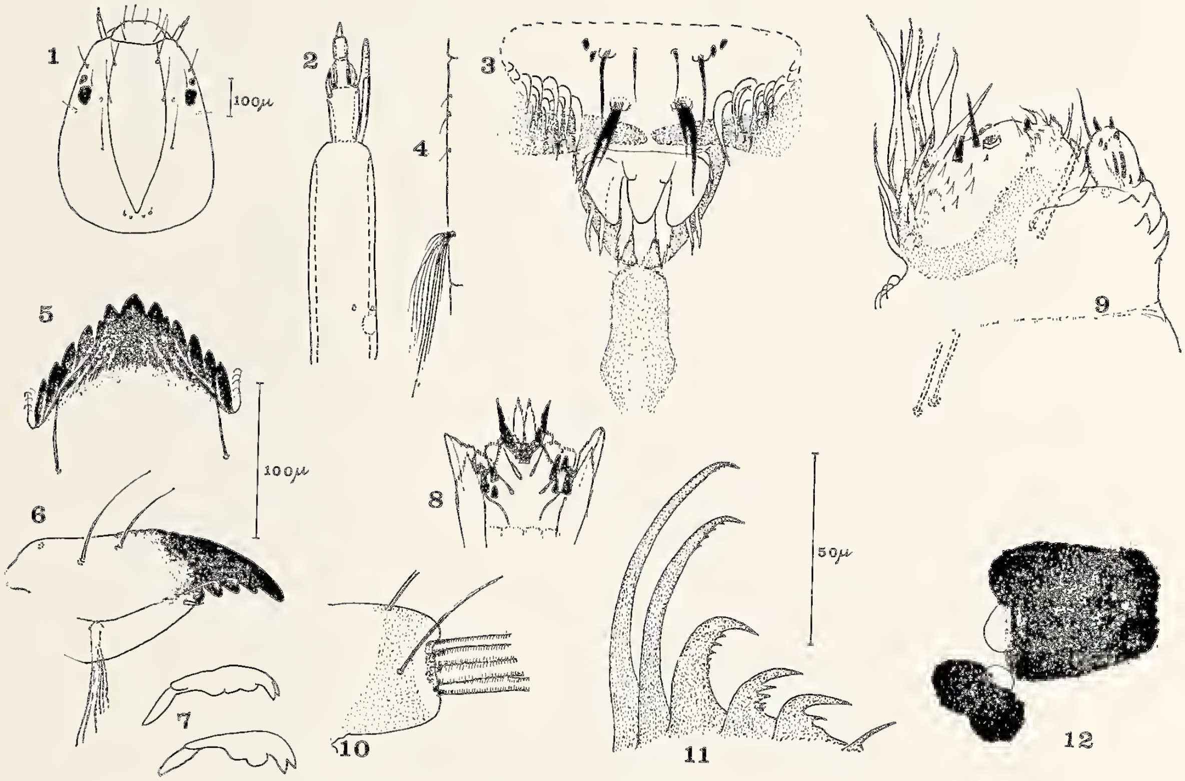


Figure 186. *Cricotopus (Isocladius) trifasciatus* (Meig.), "small form," larva. Head, dorsal (1); antenna (2); palatal surface of labrum (3); L setae of abdominal segment IV (4); mentum (5); mandible (6); premandible (7); prementum (8); maxilla (9); procercus (10); claws of anterior parapods (11); eyespots (12). Scale of drawings 1=4; 2=3, 8−12; 5=6−7.

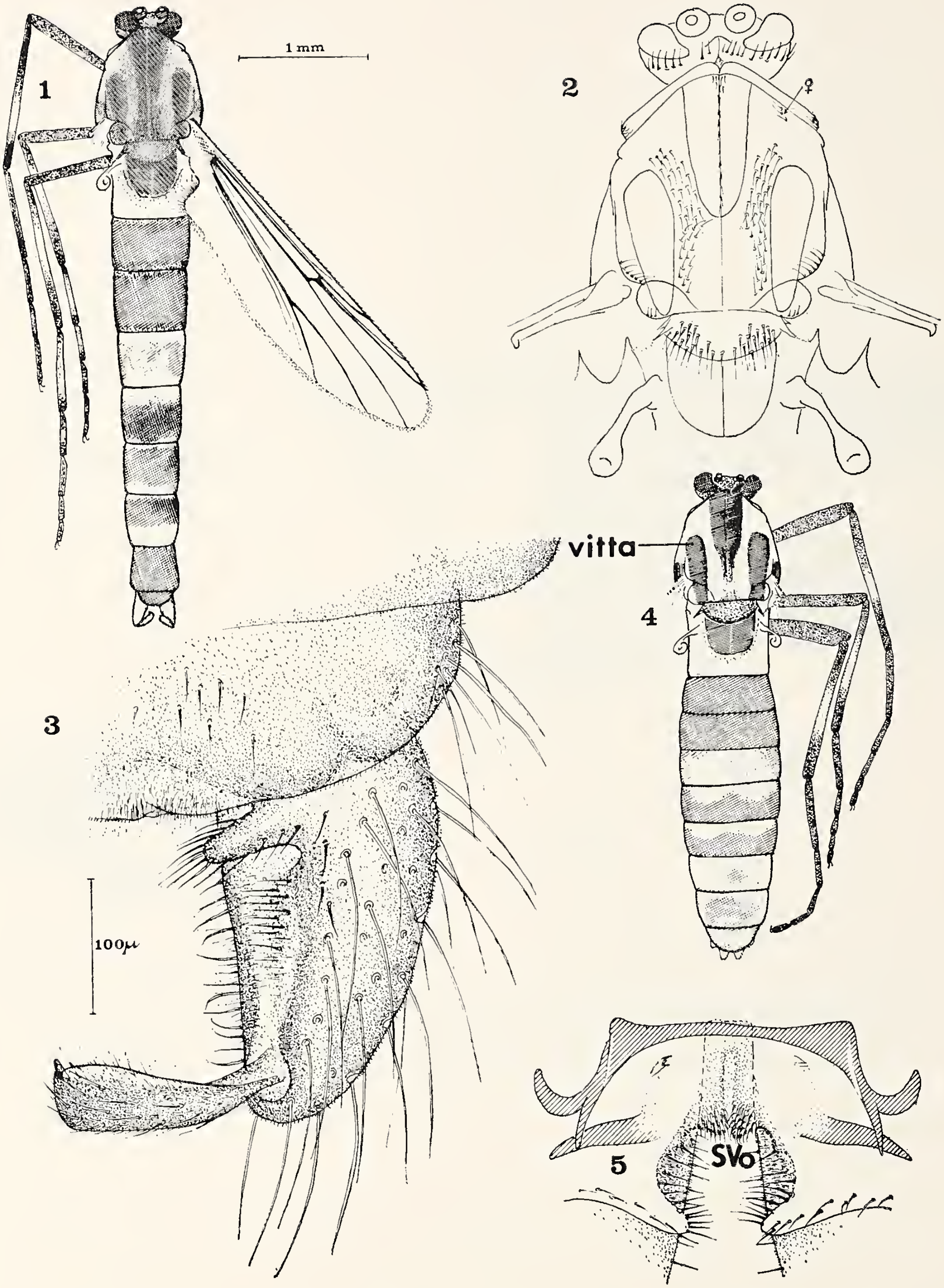


Figure 187. *Cricotopus (Isocladius) speciosus* Goetgh., adult. ♂ (1); chaetotaxy scheme for head and thorax, dorsal (2); hypopygium of ♂ (3); ♀ (4); aedeagal lobe and phallapodeme of hypopygium (5). Scale of drawings 1=4; 3=5.—SVo superior volsella.

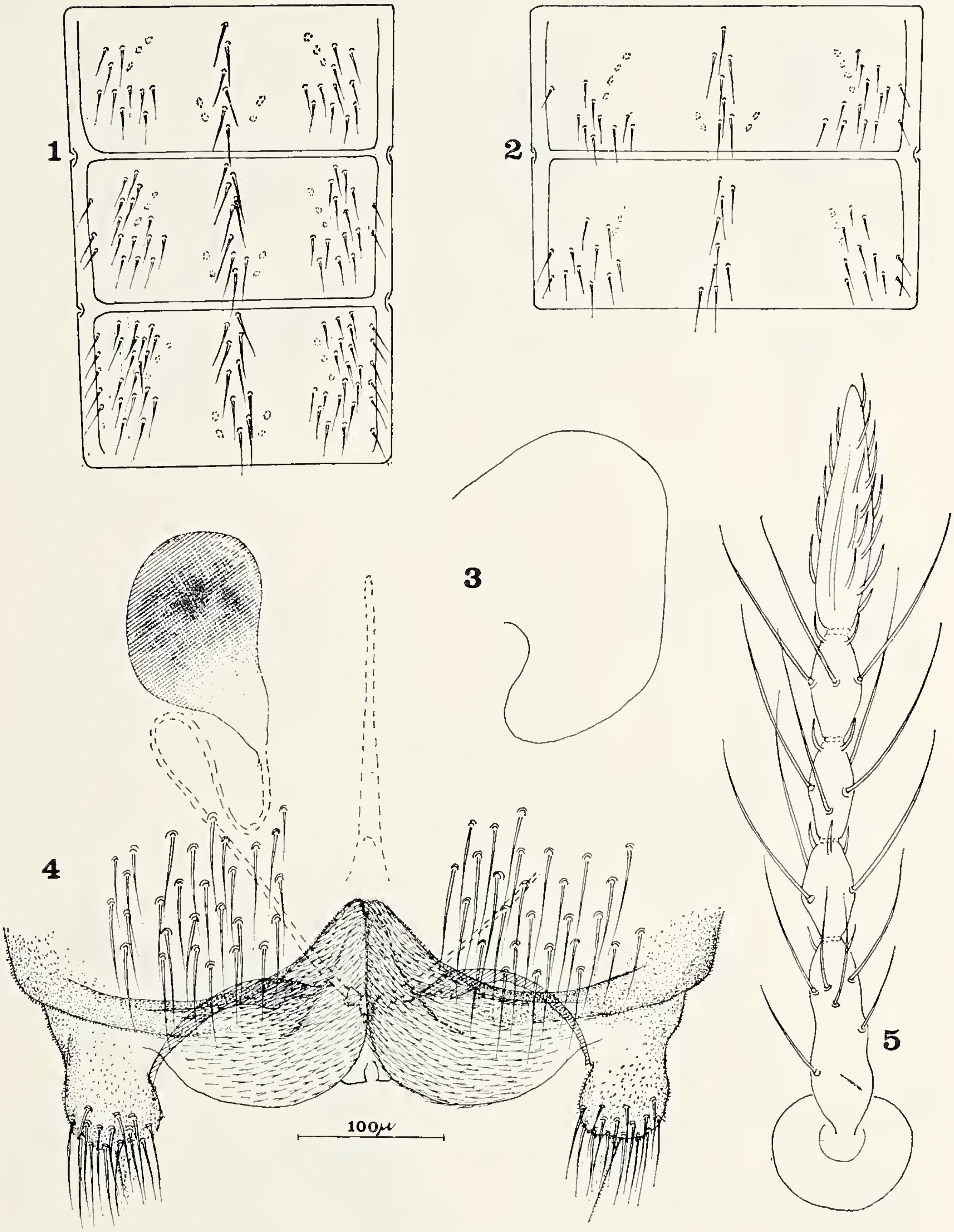


Figure 188. *Cricotopus (Isocladius) speciosus* Goetgh., adult. Chaetotaxy scheme for abdominal tergites II–IV of ♂ (1); same for III–IV of ♀ (2); cercus (3); spermatheca and outer genitalia of ♀ (4); antenna of ♀ (5). Scale of drawings 3=4–5.

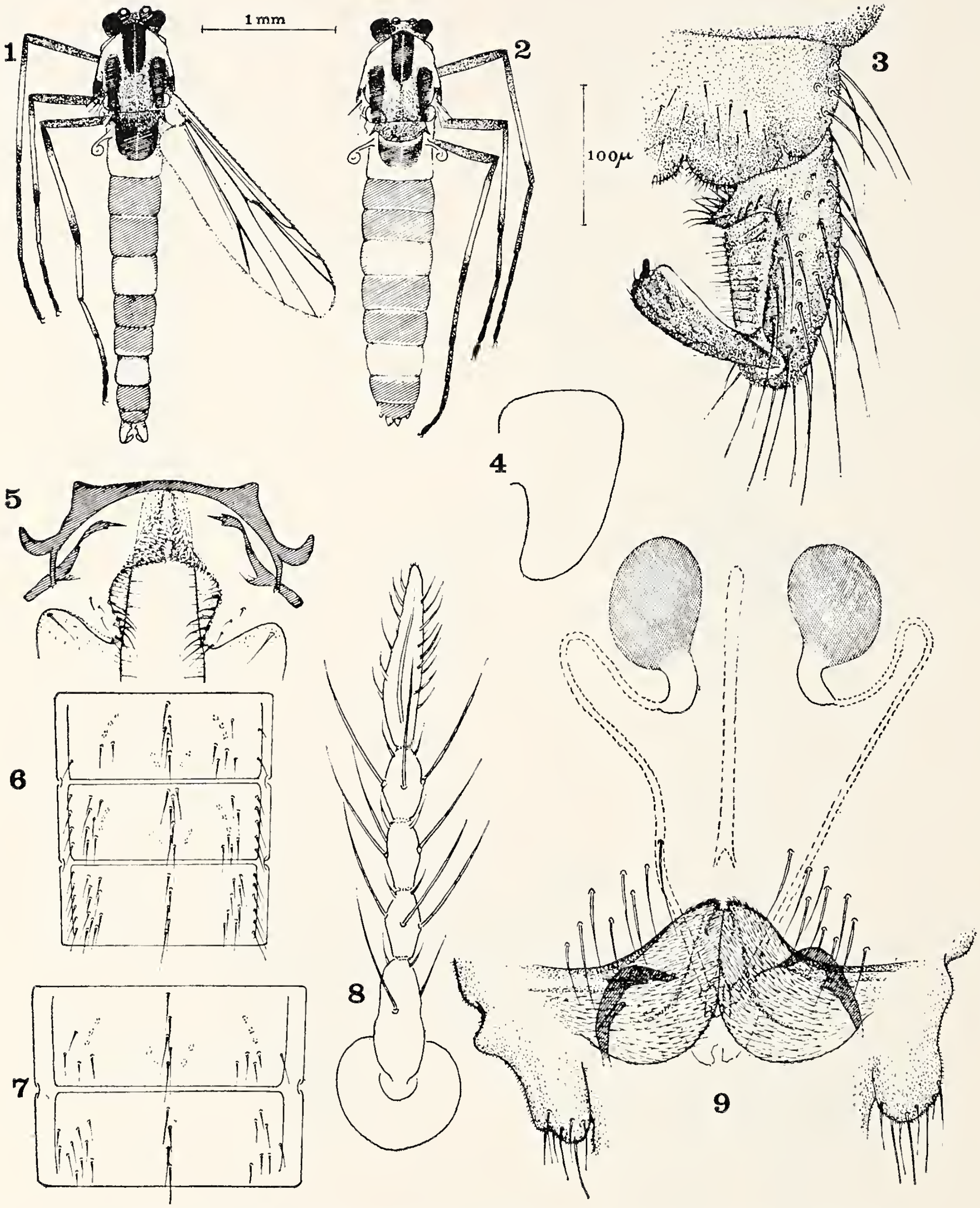


Figure 189. *Cricotopus (Isocladius) tricinctus* (Meig.), adult. ♂ (1); ♀ (2); hypopygium of ♂ (3); cercus of ♀ (4); aedeagal lobe and phallapodeme of hypopygium (5); chaetotaxy scheme for abdominal tergites II–IV of ♂ (6); same for III–IV of ♀ (7); antenna (8); spermathecae and outer genitalia of ♀ (9). Scale of drawings 1=2; 3=4–5, 8–9.

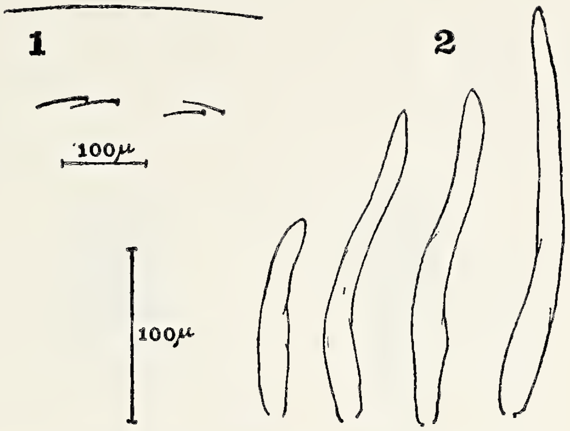


Figure 190. *Cricotopus (Isocladius) tricinctus* (Meig.), pupa. Size relationship and arrangement of Dc setae (1); thoracic horn (2).

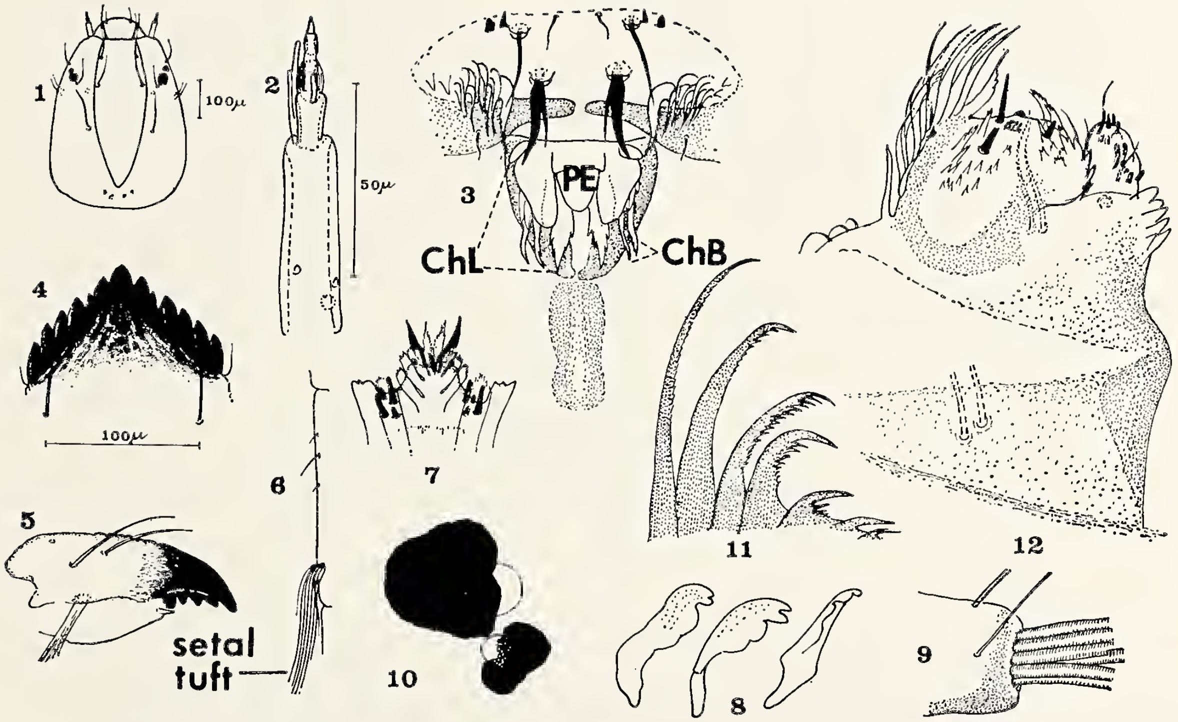


Figure 191. *Cricotopus (Isocladius) tricinctus* (Meig.), larva. Head, dorsal (1); antenna (2); palatal surface of labrum (3); mentum (4); mandible (5); L setae of abdominal segment IV (6); prementum (7); variation in premandible by different views (8); procercus (9); eyespots (10); claws of anterior parapods (11); maxilla (12). Scale of drawings 1=6; 2=3, 7, 9–12; 4=5, 8.—ChB chaetulae basales, ChL chaetulae laterales, PE pecten epipharyngis.

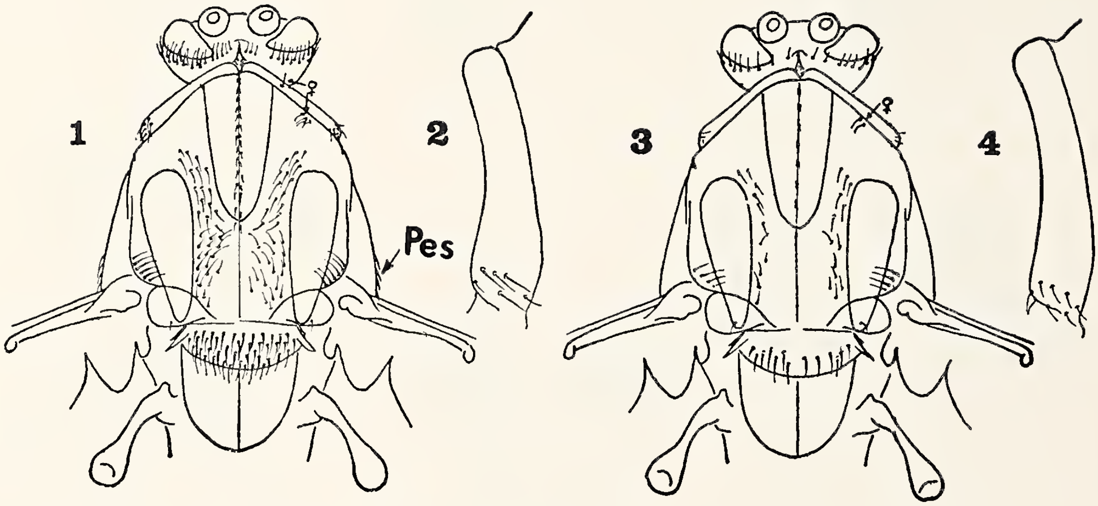


Figure 192. *Cricotopus (Isocladius) reversus* Hirv., (1–2) and *C.* (*I.*) *perniger* (Zett.) (3–4). Chaetotaxy scheme for head and thorax, dorsal and antepronotum.—Pes preepisternal setae.

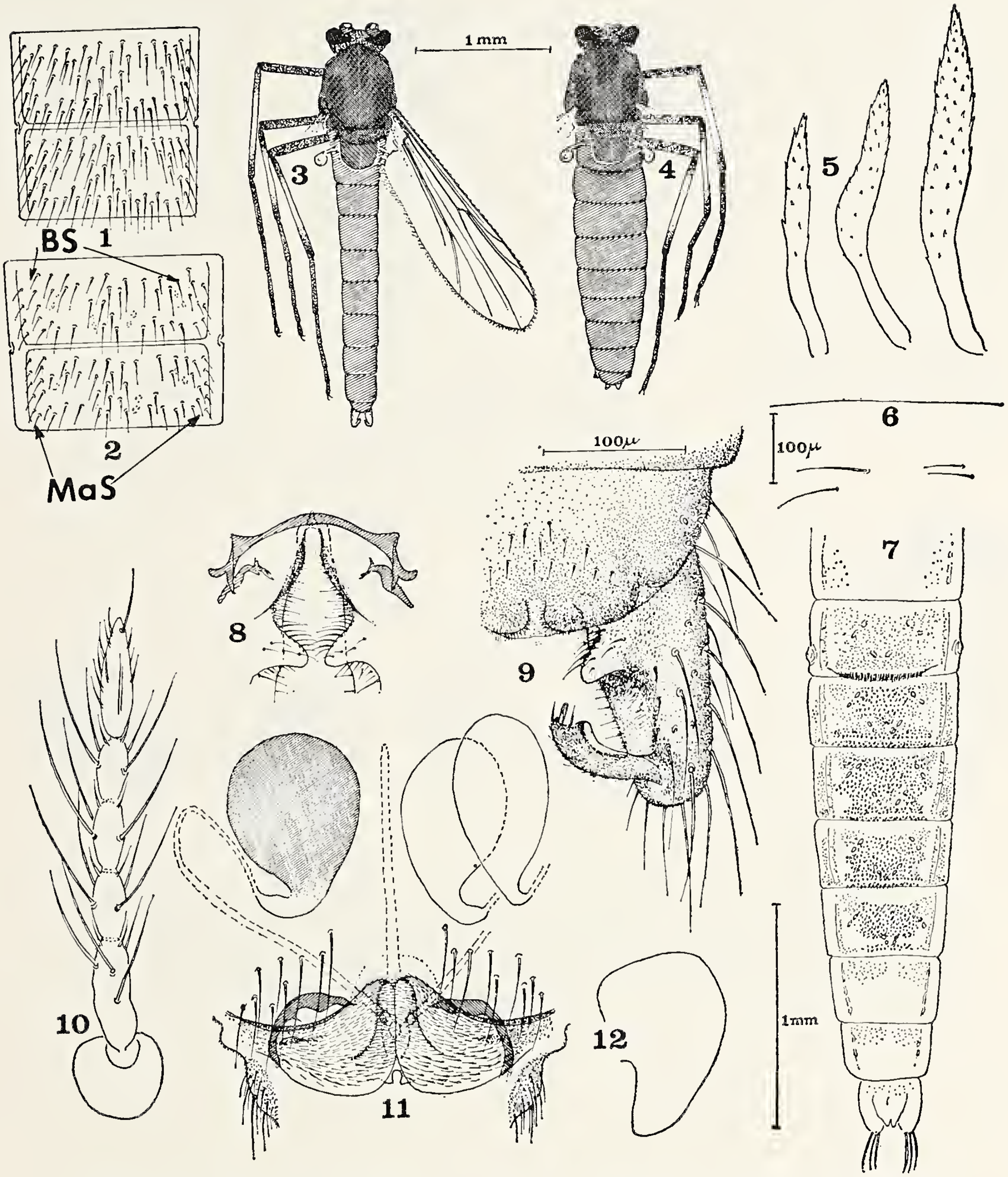


Figure 193. *Cricotopus (Isocladius) reversus* Hirv., adult, pupa. Chaetotaxy scheme for abdominal tergites III and IV of ♂ (1); same of ♀ (2); ♂ (3); ♀ (4); thoracic horn (5); size relationship and arrangement of Dc setae of pupa (6); shagreen of abdominal segments of pupa (7); aedeagal lobe and phallapodeme of hypopygium (8); hypopygium (9); antenna (10); variation in spermathecae and outer genitalia of ♀ (11); cercus of ♀ (12). Scale of drawings 3=4; 5=8−12. —BS basal setae, MaS marginal setae.

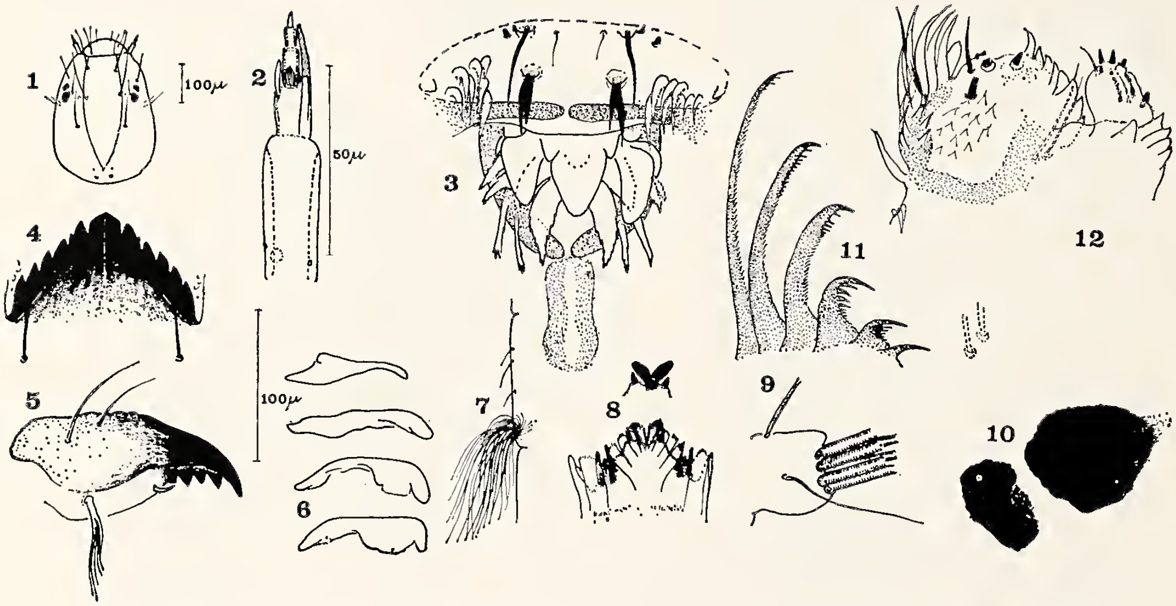


Figure 194. *Cricotopus (Isocladius) reversus* Hirv., larva. Head, dorsal (1); antenna (2); palatal surface of labrum (3); mentum (4); mandible (5); variation in premandible with different views (6); L setae of abdominal segment V (7); prementum (above, apical part with appendage L and apical sensillae basiconicae) (8); procercus (9); eyespots (10); claws of anterior parapods (11); maxilla (12). Scale of drawings 1=7; 2=3, 8–12; 4=5–6.

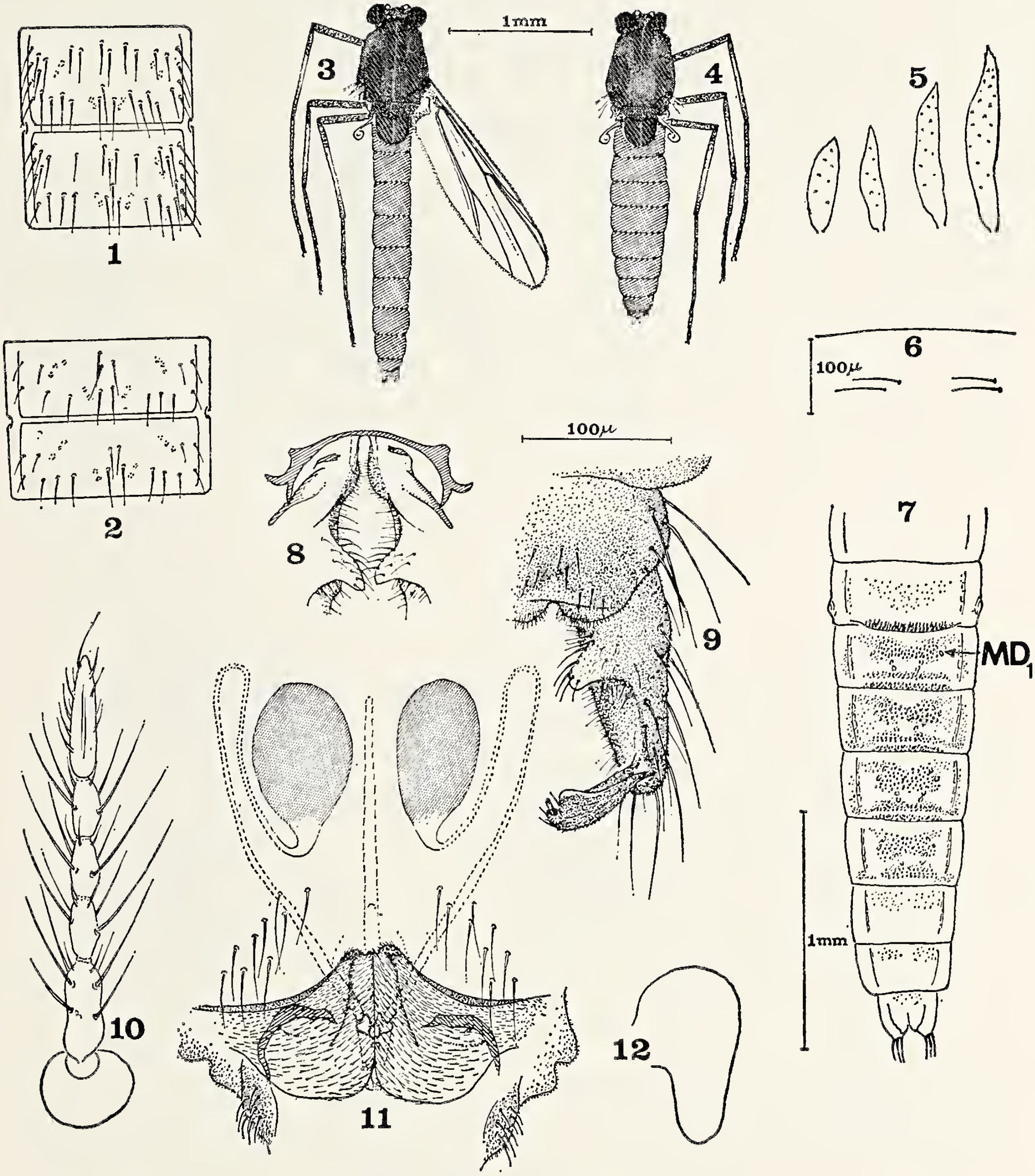


Figure 195. *Cricotopus (Isocladius) perniger* (Zett.), adult, pupa. Chaetotaxy scheme for abdominal tergites III–IV of ♂ (1); same of ♀ (2); ♂ (3); ♀ (4); variation in thoracic horn (5); size relationship and arrangement of Dc setae of pupa (6); shagreen of abdominal segments of pupa (7); aedeagal lobe and phallapodeme of hypopygium (8); hypopygium (9); antenna (10); spermathecae and outer genitalia of ♀ (11); cercus of ♀ (12). Scale of drawings 3=4; 5=8−12. —MD$_1$ anteromedian muscle marks.

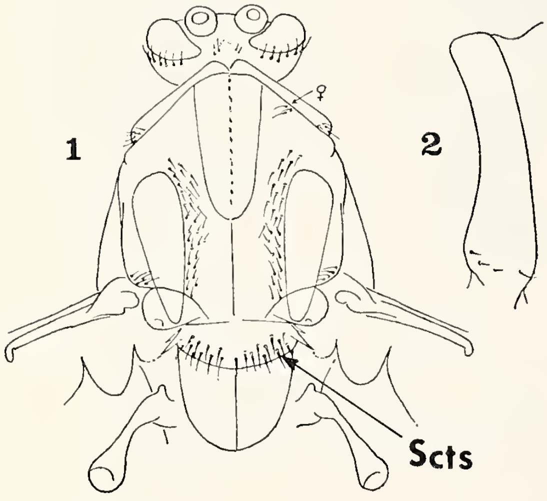


Figure 196. *Cricotopus (Isocladius) intersectus* (Staeg.), adult. Chaetotaxy scheme for head and thorax, dorsal (1); antepronotum, lateral (2).—Scts scutellar setae.

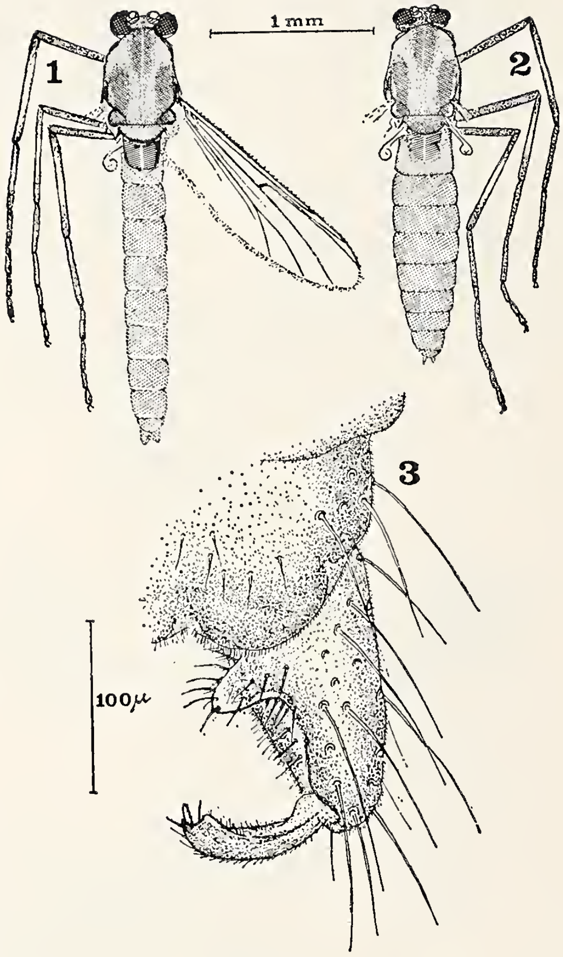


Figure 197. *Cricotopus (Isocladius) intersectus* (Staeg.), adult. ♂ (1); ♀ (2); hypopygium of ♂ (3). Dark, proportionately smaller animals, which among others are similar to the type specimens.

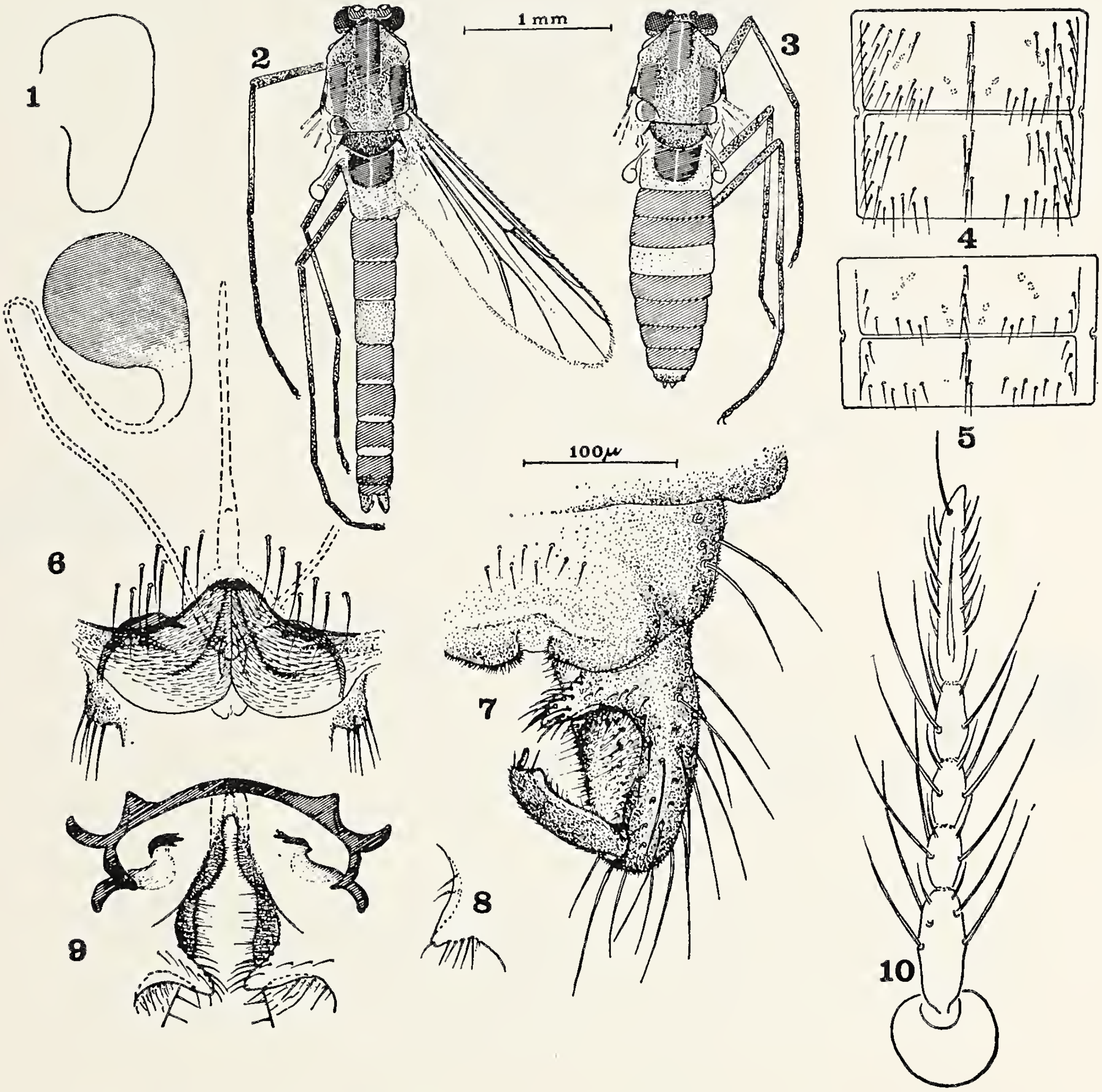


Figure 198. *Cricotopus (Isocladius) intersectus* (Staeg.), adult (most drawn after animals from Lake Sompiojärvi, Finnish-Lappland). Cercus of ♀ (1); ♂ (2); ♀ (3); chaetotaxy scheme for abdominal tergites III–IV of ♂ (4); same of ♀ (5); spermatheca and outer genitalia of ♀ (6); hypopygium (7); example of variation in inferior volsella (Fulda, Germany) (8); aedegal lobe and phallapodeme of hypopygium of ♂ (9); antenna of ♀ (10); Scale of drawings 1=6–10; 2=3.

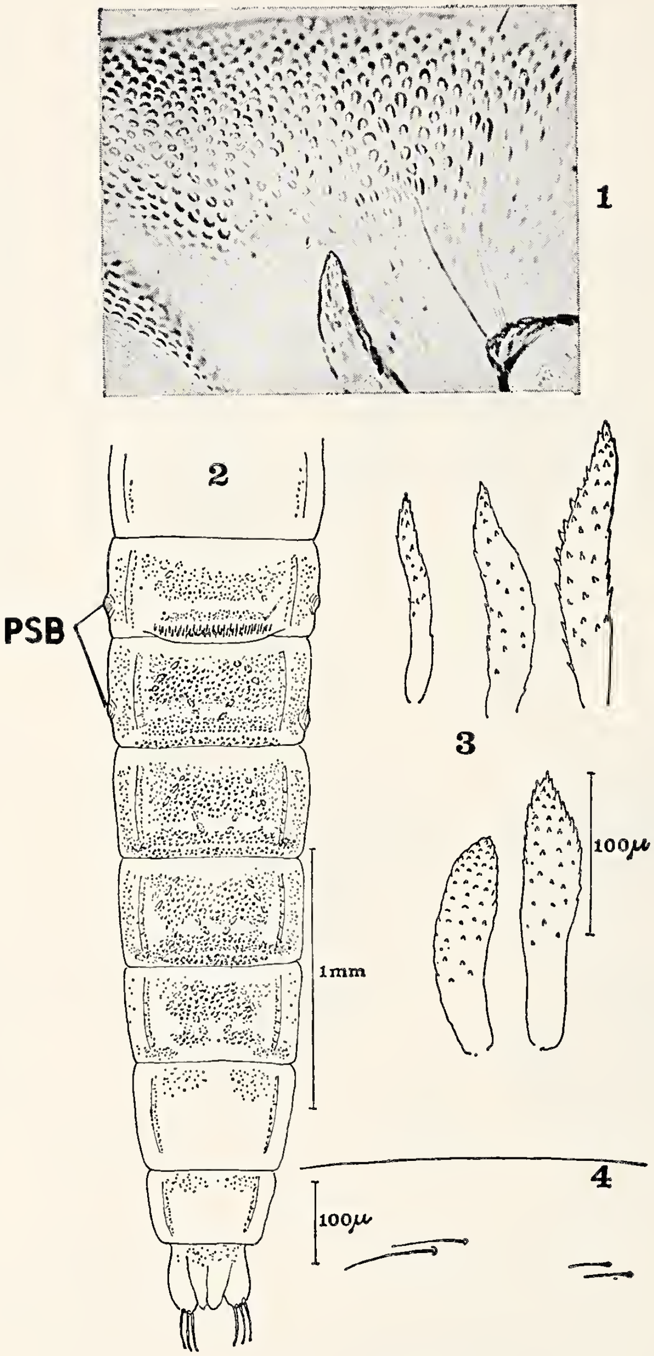


Figure 199. ***Cricotopus (Isocladius) intersectus*** (Staeg.), pupa. Thoracic region, dorsal ("granular") (1); shagreen of abdominal segments (2); variation in thoracic horn (above left from Riihimäki, in middle Espoobrackish water—and right, Sompiojärvi, Sodankylä, all from Finland; below, example from Lake Constance region, Germany) (3); size relationship and arrangement of Dc setae (4).—PSB pedes spurii B.

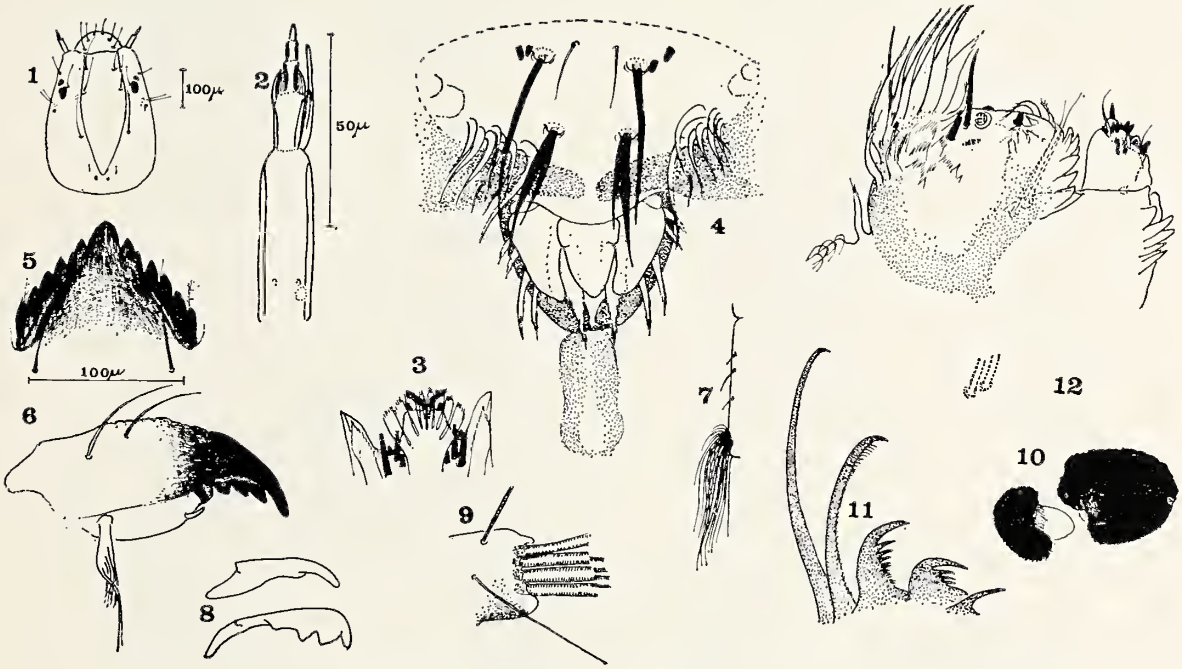


Figure 200. *Cricotopus (Isocladius) intersectus* (Staeg.), larva. Head, dorsal (1); antenna (2); prementum (3); palatal surface of labrum (4); mentum (5); mandible (6); L setae of abdominal segment V (7); variation in premandible with different views (8); procercus (9); eyespots (10); claws of anterior parapods (11); maxilla (12). Scale of drawings 1=7; 2=3–4, 9–12; 5=6, 8.

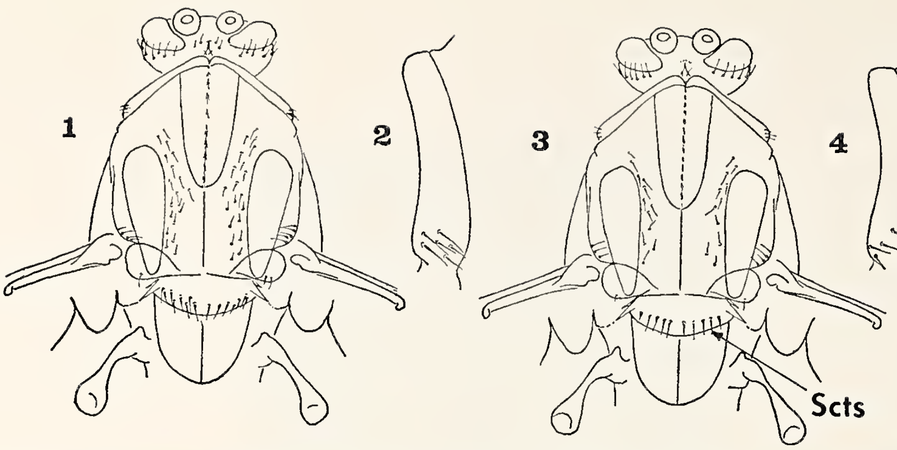


Figure 201. *Cricotopus (Isocladius) arcuatus* Hirv., (1–2) and *C. (I.) laricomalis* Edw. (3–4). Chaetotaxy of head and thorax of ♂ dorsal and antepronotum, lateral.—Scts scutellar setae.

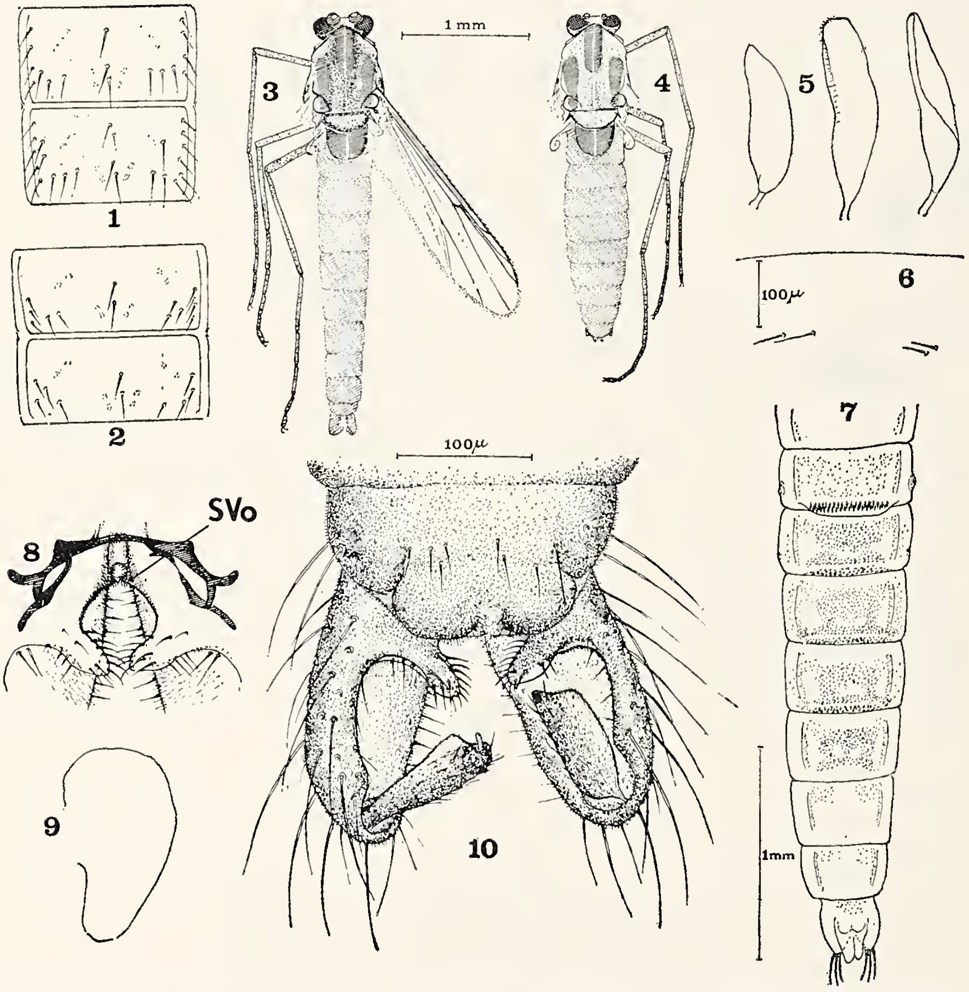


Figure 202. *Cricotopus (Isocladius) arcuatus* Hirv., adult, pupa. Chaetotaxy scheme for abdominal tergites III–IV of ♂ (1); same of ♀ (2); ♂ (3); ♀ (4); variation in thoracic horn (5); size relationship and arrangement of Dc setae of pupa (6); shagreen of abdominal tergites of pupa (7); aedeagal lobe and phallapodeme of hypopygium (8); cercus of ♀ (9); hypopygium (10). Scale of drawings 3=4; 5=8–10.—SVo superior volsella.

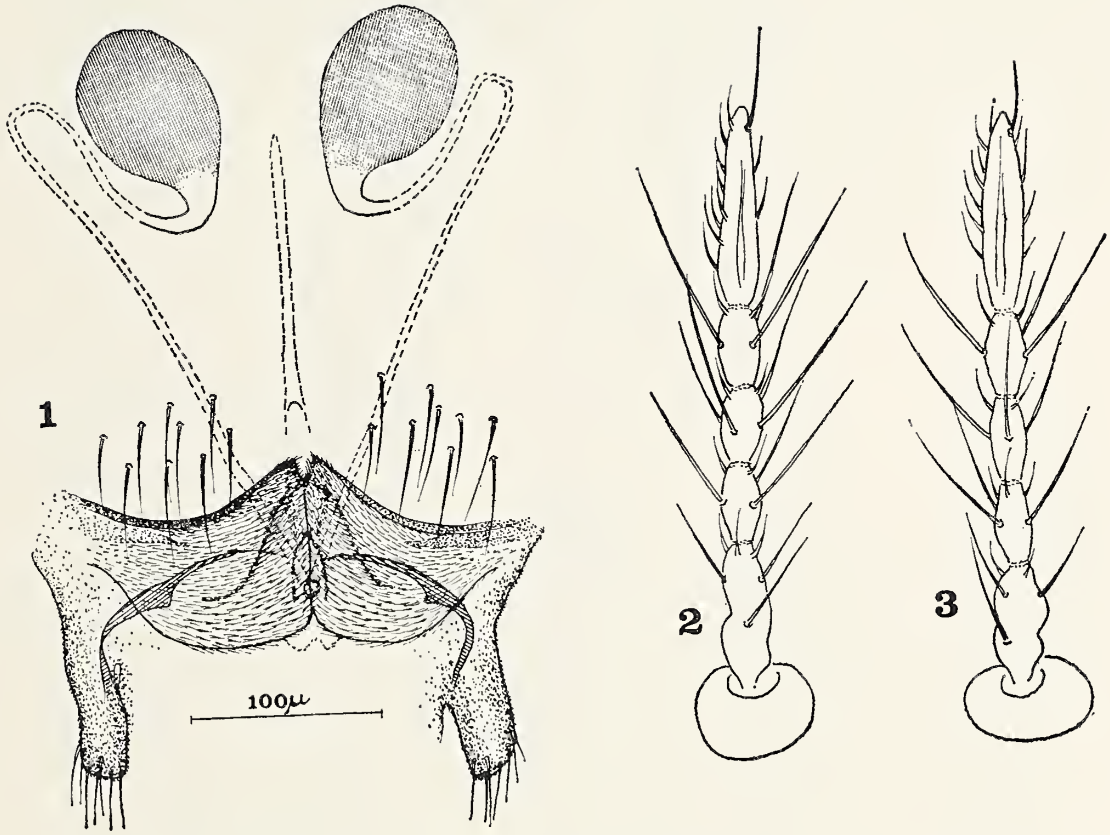


Figure 203. Spermathecae and outer genitalia (1) and antenna (2) of ♀ of *Cricotopus (Isocladius) arcuatus* Hirv.; antenna of ♀ of *C. (I.) obnixus* (Walk.) (3).

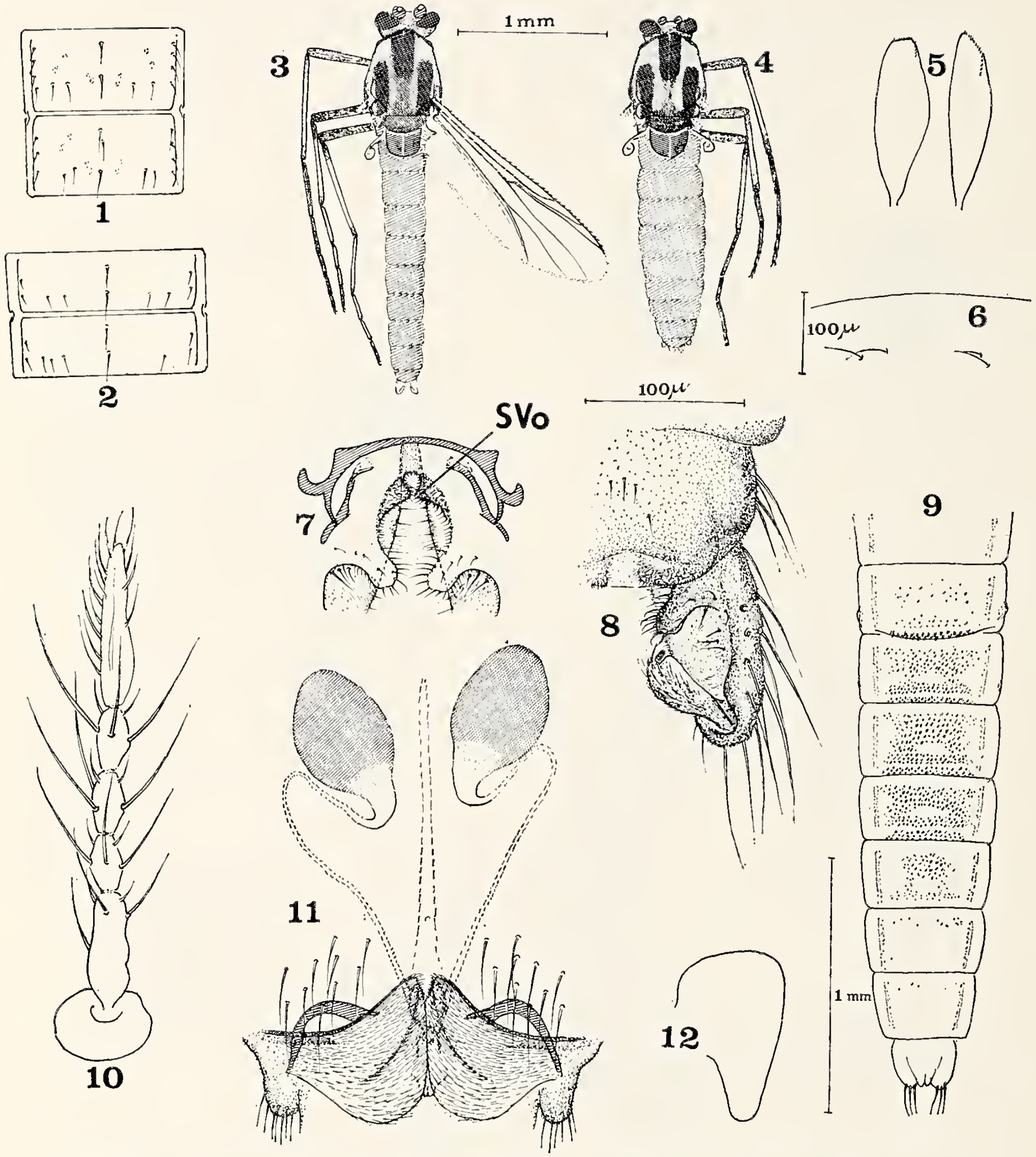


Figure 204. *Cricotopus (Isocladius) obtusus* Hirv., adult, pupa. Chaetotaxy scheme for abdominal segments III–IV of ♂ (1); same of ♀ (2); ♂ (3); ♀ (4); variation in thoracic horn (5); size relationship and arrangement of Dc setae of pupa (6); aedeagal lobe and phallapodeme of hypopygium (7); hypopygium (8); shagreen of abdominal segments of pupa (9); antenna (10); spermathecae and outer genitalia of ♀ (11); cercus of ♀ (12). Scale of drawings 3=4; 5=7–8, 10–12.—SVo superior volsella.

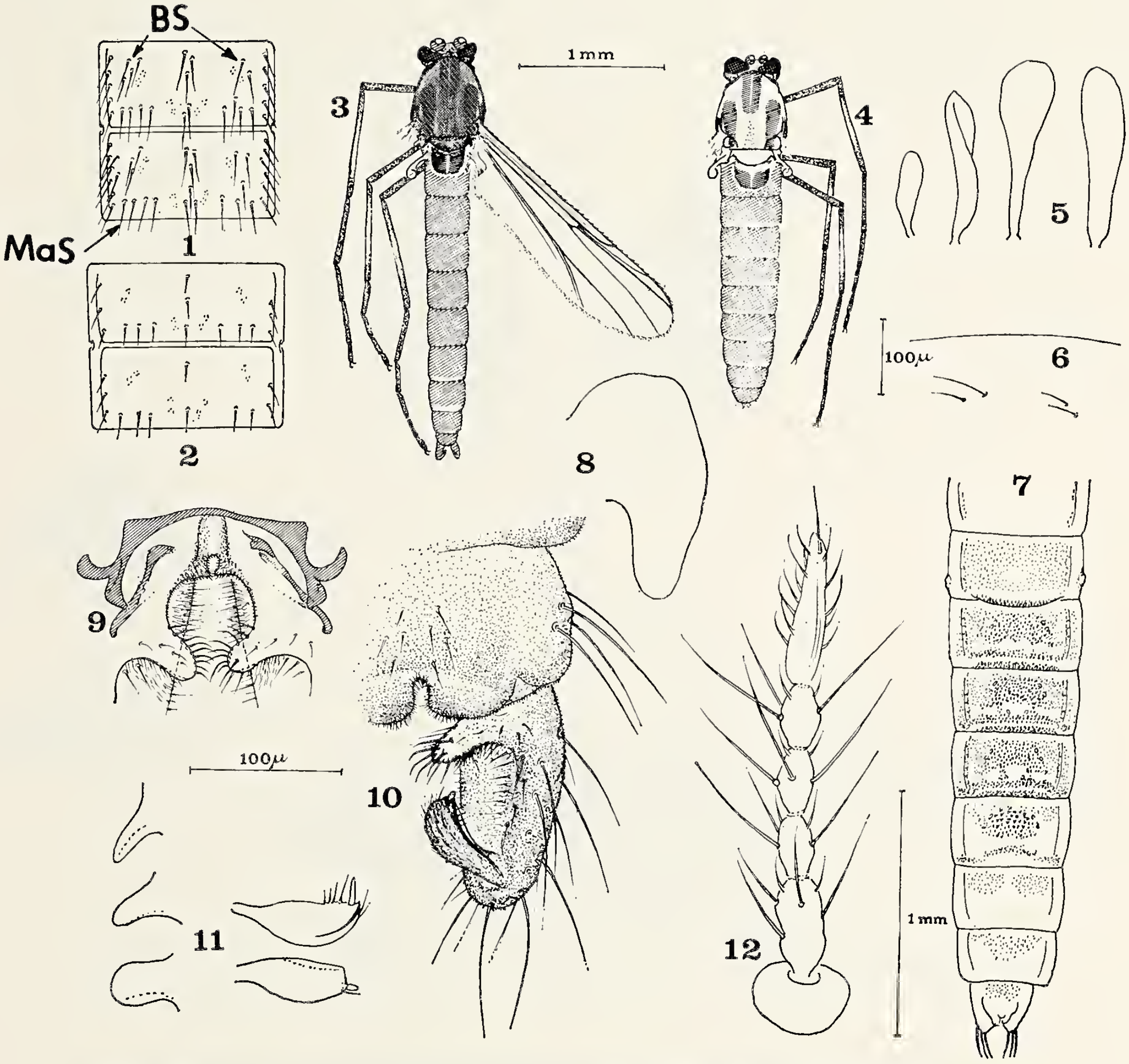


Figure 205. *Cricotopus (Isocladius) laricomalis* Edw., adult, pupa. Chaetotaxy scheme for abdominal tergites III–IV of ♂ (1); same of ♀ (2); ♂ (3); ♀ (4); variation in thoracic horns (5); size relationship and arrangement of Dc setae of pupa (6); shagreen of abdominal tergites of pupa (7); cercus of ♀ (8); aedeagal lobe and phallapodeme of hypopygium (9); hypopygium (10); variation of inferior volsella (left) and stylus of ♂ (11); antenna of ♀ (12). Scale of drawings 3=4; 5=8–12.—BS basal setae, MaS marginal setae.

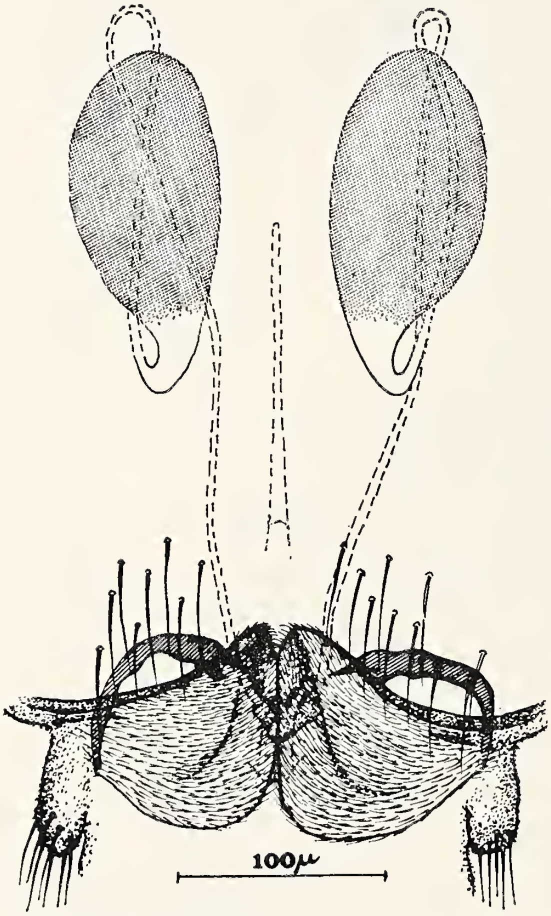


Figure 206. *Cricotopus (Isocladius) laricomalis* Edw., spermathecae and outer genitalia of ♀.

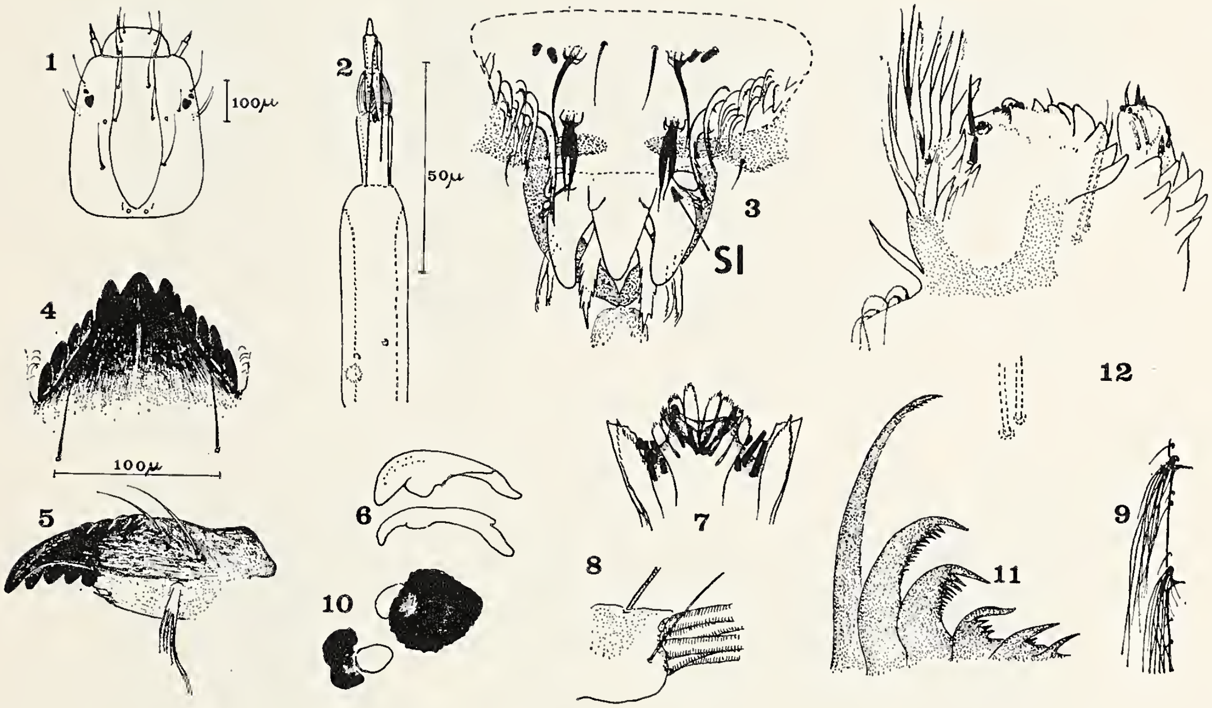


Figure 207. *Cricotopus (Isocladius) laricomalis* Edw., Head, dorsal (1); antenna (2); palatal surface of labrum (3); mentum (4); mandible (5); variation in premandible with different views (6); prementum (7); procercus (8); L setae of abdominal segment IV (9); eyespots (10); claws of anterior parapods (11); maxilla (12). Scale of drawings 1=9; 2=3, 7–8, 10–12; 4=5–6.—SI seta anteriores.

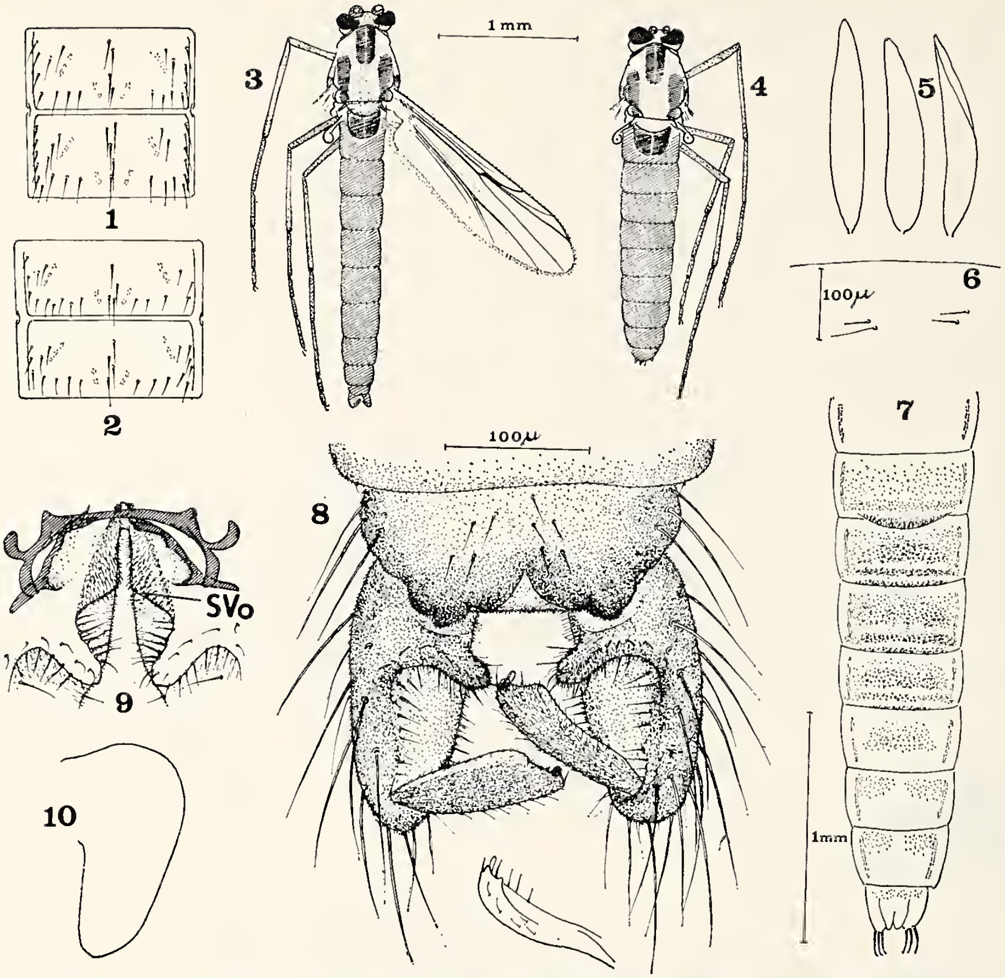


Figure 208. *Cricotopus (Isocladius) obnixus* (Walk.), adult, pupa. Chaetotaxy scheme for abdominal tergites III–IV of ♂ (1); same of ♀ (2); ♂ (3); ♀ (4); variation in thoracic horn (5); arrangement and size relationship of Dc setae of pupa (6); shagreen (in the illustration is an uncommon specimen, anterior and posterior spinule fields often are more confluent) of abdominal tergites of pupa (7); hypopygium (below, stylus with different view) (8); aedeagal lobe and phallapodeme of hypopygium (9); cercus of ♀ (10). Scale of drawings 3=4; 5=8–10.—SVo superior volsella.

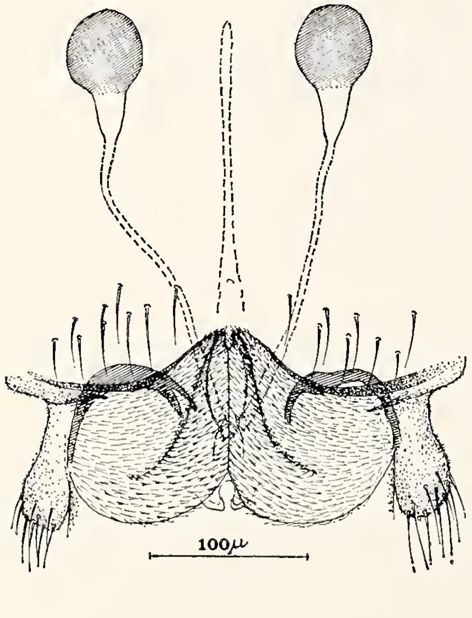


Figure 209. *Cricotopus (Isocladius) obnixus* (Walk.), spermathecae and outer genitalia of ♀.

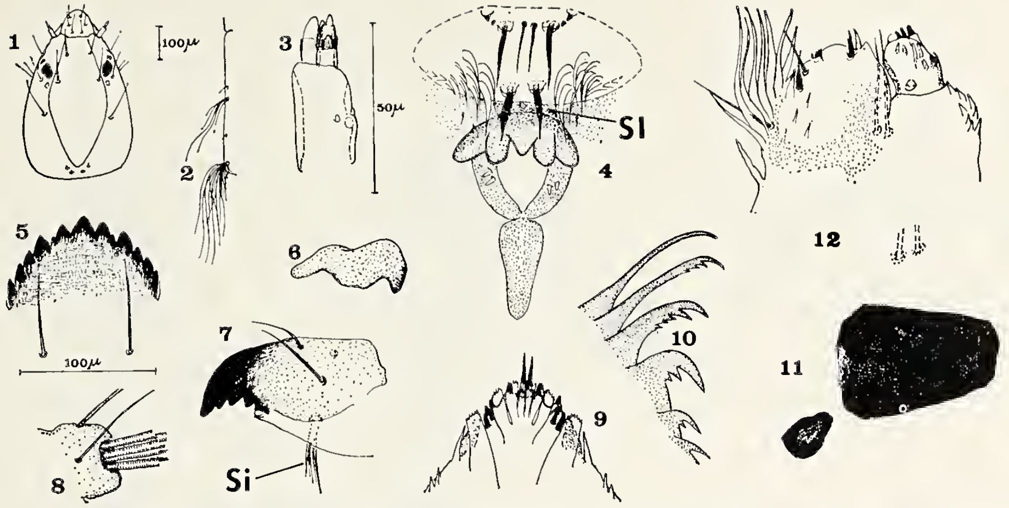


Figure 210. *Cricotopus (Isocladius) elegans* Joh. [? *obnixus* (Walk.)], larva. Head, dorsal (1); L setae of abdominal segment V (2); antenna (3); palatal surface of labrum (4); mentum (5); premandible (6); mandible (7); procercus (8); prementum (9); claws of anterior parapods (10); eyespots (11); maxilla (12). Scale of drawings 1=2; 3=4, 8−12; 5=6−7.—S_i seta interna, SI seta anteriores.

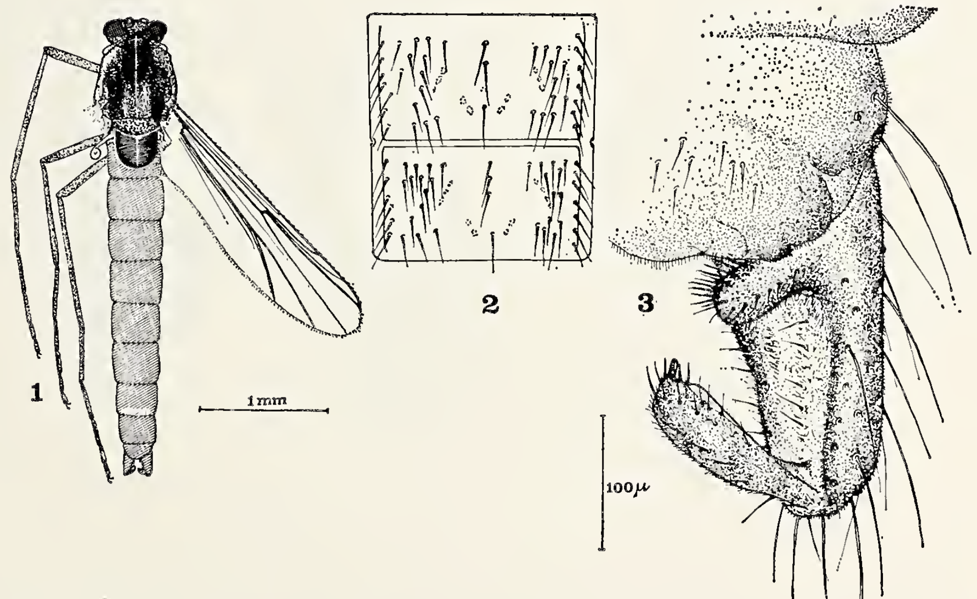


Figure 211. *Cricotopus (Isocladius)* sp., cfr. *obnixus* (Walk.). ♂ (1); chaetotaxy scheme for abdominal tergites III–IV of ♂ (2); hypopygium of ♂ (3).

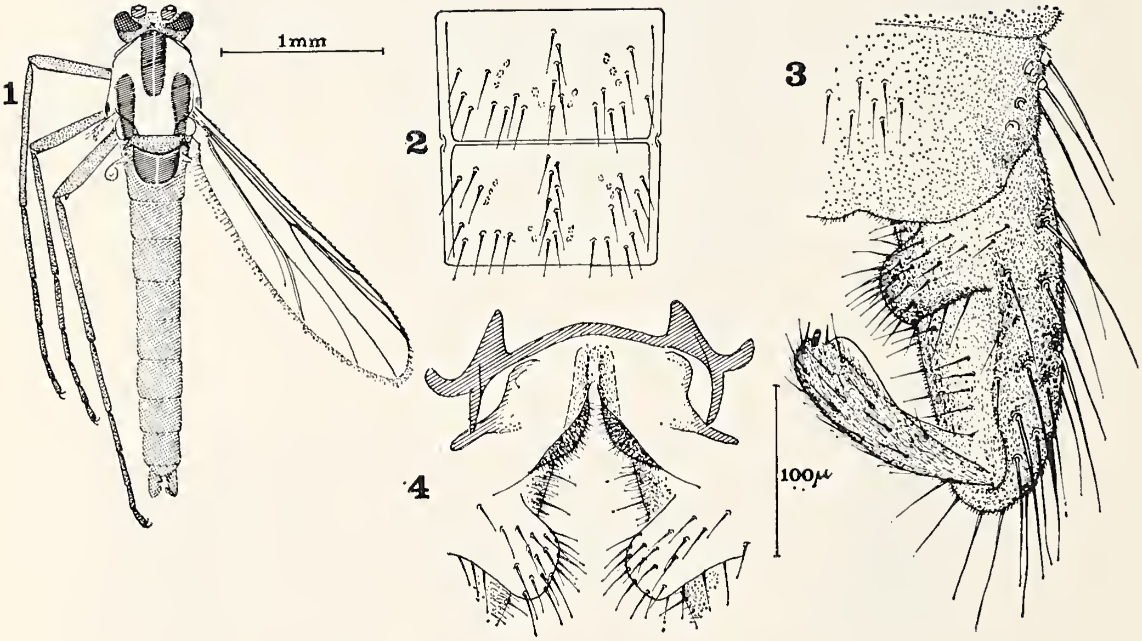


Figure 212. *Cricotopus (Isocladius) reductus* Hirv., ♂ (1); chaetotaxy scheme for abdominal tergites III–IV of ♂ (2); hypopygium (3); aedeagal lobe and phallapodeme of hypopygium (4).

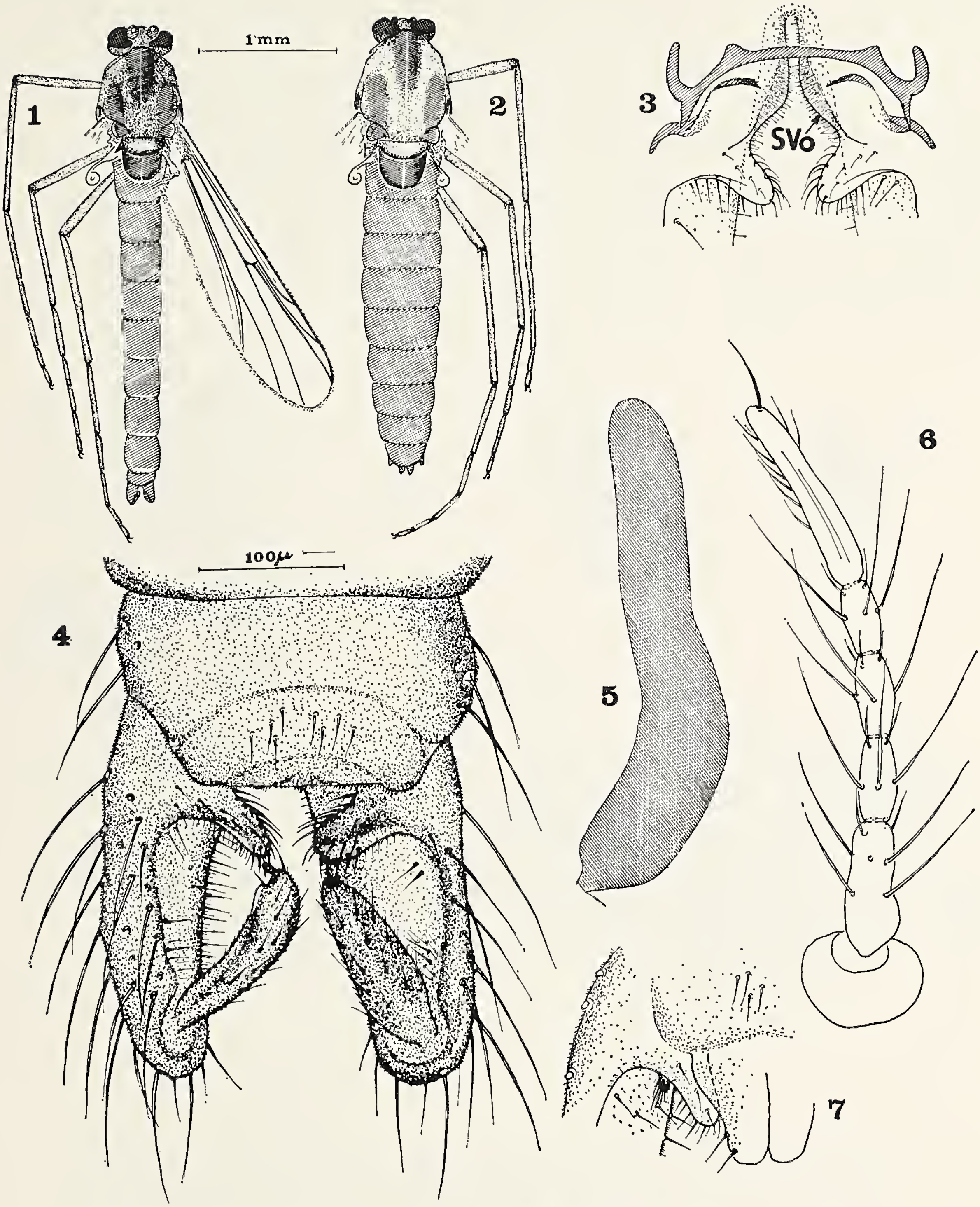


Figure 213. *Cricotopus (Isocladius) brevipalpis* Kieff., adult, pupa. ♂ (1); ♀ (2); aedeagal lobe and phallapodeme of hypopygium (3); hypopygium (4); thoracic horn of pupa (5); antenna of ♀ (6); deviated hypopygium of ♂ with indication of appendage 2 under inferior volsella and with two setae on proctiger (7). Scale of drawings 1=2; 3=4–7.—SVo superior volsella.

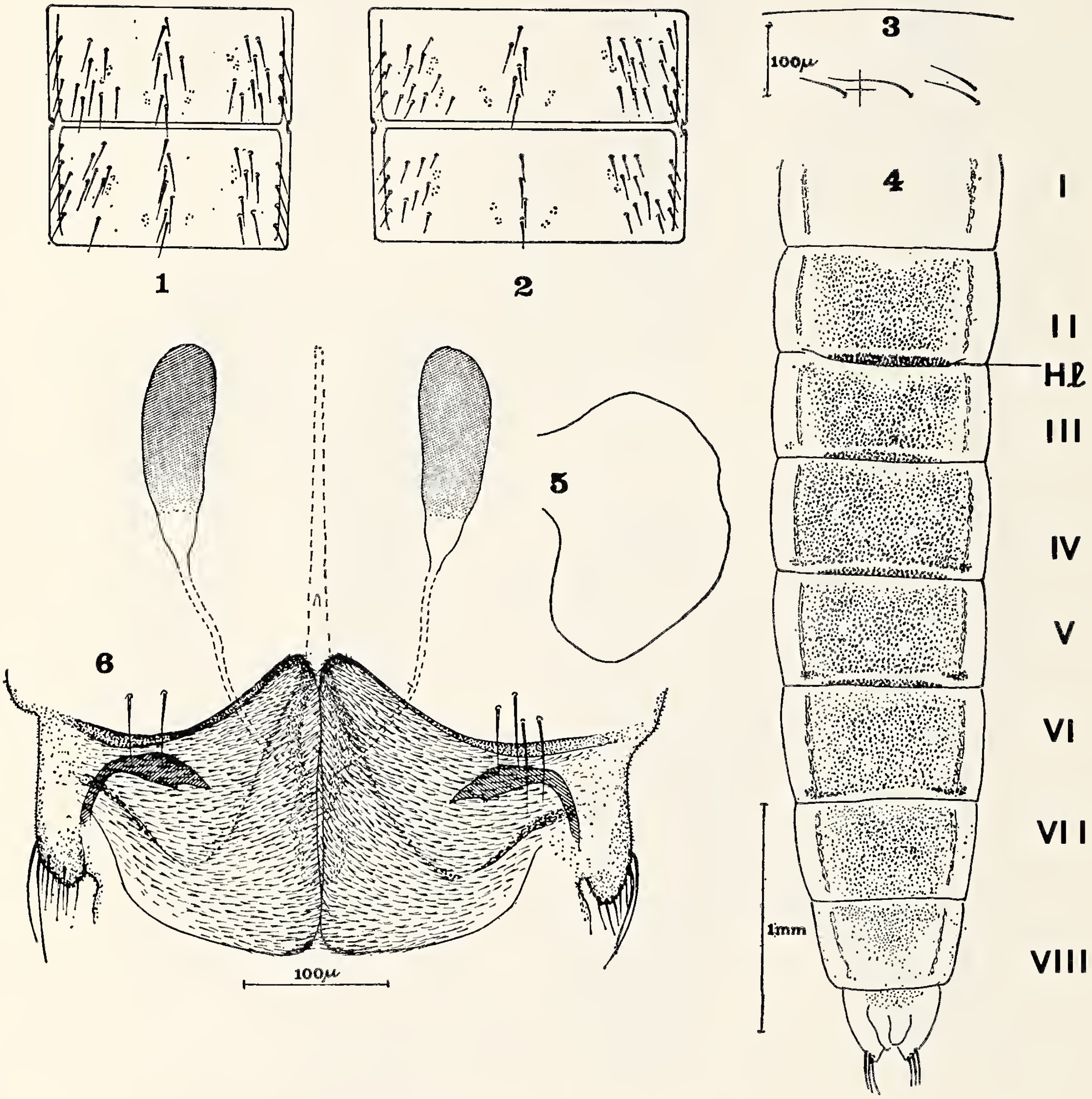


Figure 214. *Cricotopus (Isocladius) brevipalpis* Kieff., adult, pupa. Chaetotaxy scheme for abdominal tergites III–IV of ♂ (1); same of ♀ (2); size relationship and arrangement of Dc setae of pupa (3); shagreen of abdominal segments of pupa (4); cercus of ♀ (5); spermathecae and outer genitalia of ♀ (6). Scale of drawings 5=6.—Hl hooklets.

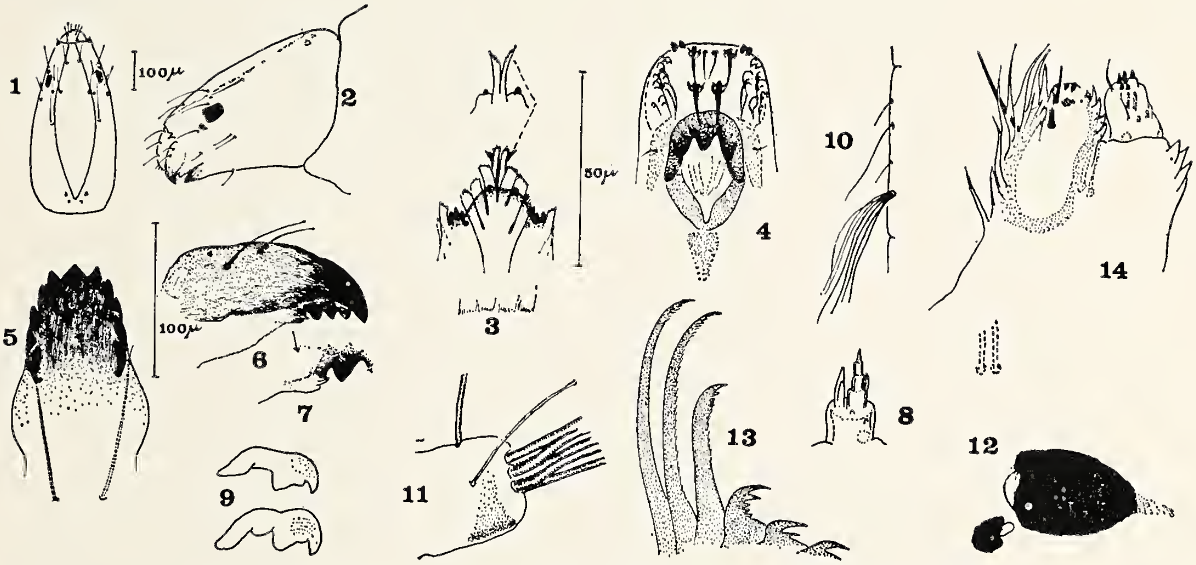


Figure 215. *Cricotopus (Isocladius) brevipalpis* Kieff., larva. Head, dorsal (1); head, lateral (2); prementum (above, appendage L) (3); palatal surface of labrum (4); mentum (5); mandible (6); region of last free tooth and SSd of mandible enlarged (7); antenna (8); premandible (9); L setae of abdominal segment IV (10); procercus (11); eyespots (12); claws of anterior parapods (13); maxilla (14). Scale of drawings 1=2–10; 3=4, 7, 8, 11–14; 5=6, 9.

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